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THE UNIVERSITY OF ALBERTA

A STUDY OF THE WILDLIFE OF FOUR SELECTED EDMONTON RAVINES AND OF THE RECREATION USES AND PREFERENCES FOR CITY RAVINES

by

© RICHARD BRUCE SPENCER

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF GEOGRAPHY

EDMONTON, ALBERTA

FALL, 1976

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled A Study of the Wildlife of Four Selected Edmonton Ravines and of the Recreation Uses and Preferences for City Ravines submitted by Richard Bruce Spencer
in partial fulfilment of the requirements for the degree of Master of Science.

Don Gill
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Supervisor

. . . . . .

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Date . . . . . .

ABSTRACT

During 1972 and 1973, investigations of wildlife habitat, wildlife populations, and recreation were conducted in four selected river valley ravines within the City of Edmonton, Canada. It was hypothesized that the degree of road development in these ravines would influence the status of wildlife populations. The investigations determined that: (1) there is a diversity of wildlife habitats in the ravines and a surprising diversity of wildlife species that use these habitats, (2) there is a smaller species diversity and significantly fewer birds in the ravine with the greatest degree of road development, and (3) in all seasons investigated, more birds were observed in mixed forest habitats than in others.

A questionnaire circulated to a stratified random sample of Edmonton residents living near the study ravines determined that: (1) a large percentage of respondents used the ravines for recreation; (2) citizens preferred and partook in non-wildlife-based recreations in the ravines to a greater extent than wildlife-based ones; and (3) income-related variables influenced whether a person was a ravine user or not, with users generally having higher incomes.

Wildlife in an urban setting may provide the last major opportunity to bring the city-dweller in contact with the realities of nature. It may also foster the interest and the incentive needed for the city-bred citizen to partake wholesomely in the outdoor sports of hunting and fishing and perhaps hiking and camping as well.

(Stearns 1967)

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   The results and conclusions of this study do not necessarily reflect the views or policies of Environment Canada.

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CHAPTER 1

INTRODUCTION

1.1 Background

Accompanying the newly developed level of environmental awareness of the twentieth century, has been a growth in the number of participants in the non-consumptive and appreciative uses of the natural world. According to the Survey of Outdoor Recreation Activity that was sponsored by the Bureau of Outdoor Recreation, the number of people in the United States who participated in nature walks in 1965 increased by 19 per cent over the number recorded in 1960 (Davey 1967).

Of special concern to politicians, urban planners, and private individuals, is the quality of life in urban centres, where the largest proportion of North Americans reside (Perloff 1969). Characteristic of technological advancement in the twentieth century has been the shifting of populations from rural to urban areas. As of 1971, 76.1 per cent of Canada's population inhabited towns of 1,000 or more persons, and 36.1 per cent lived in cities of greater than 100,000 persons (Dominion Bureau of Statistics 1971). In the United States, Shomon (1970) predicts 90 per cent of

all Americans will live in cities by the year 2000.

Problems characteristic of the quality of life in urban centres are: air quality, water quality (Ayres and Kneese 1969), and availability of recreational amenities (Clawson 1969). Living in large metropolises has, for many persons, led to a loss of contact with nature, a condition that leaves many people with an "out of tune" feeling. One may only observe the increasingly massive exit of weekend campers who are anxious to spend a few days in the peaceful quiet of a primitive area. For instance, in the five years between 1968 and 1973 the number of visitors to Jasper National Park nearly doubled and the number of persons visiting Banff National Park also demonstrated a great increase (National Parks Service 1974).

As cities grow, the surface area they cover increases, making travel outside the city for an evening walk in a natural area impossibly time-consuming. In large North American megalopolises, such travel is almost prohibitive on a weekend basis.

With proper land-use zoning, some of the demand for contact with nature could be accommodated within our cities. Through several methods, natural areas in cities could be established or at least maintained. Some means are:

1) the protection of existing urban natural areas within cities from more intensive land uses by freezing their zoning classification as "natural areas";

2) excluding any form of commercial or residential development from these areas;
3) in newly developing fringe areas, designate a certain portion of the land to be left as a natural area or greenbelt;
4) taking advantage of urban renewal projects by incorporating natural areas within the new developments (Gill and Bonnett 1973);
5) incorporating natural areas into newly planned towns in previously undeveloped areas (Gill and Bonnett 1973);
6) encouraging industrial estates to incorporate natural areas within their boundaries (Gill and Bonnett 1973);
7) incorporating natural areas into the development of such institutions as universities (Gill and Bonnett 1973); and
8) developing new neighbourhood parks or converting some already established ornamental parks to habitats more suitable for wildlife.

Providing these areas were interspersed throughout cities, citizens would have ready access to them.

Though the consumptive uses of wildlife in these urban natural areas would be impractical, non-consumptive uses would be completely in accord with urban life styles. Twiss (1967), Smith et al. (1968), Gill and Bonnett (1973), Milne and Milne (1974) and Roth (1974) describe the usefulness of urban natural areas as outdoor laboratories for field research for city school children.

To ascertain the importance of urban natural areas to wildlife and the recreation-seeking public, specific, management-oriented research needs to be undertaken (DeGraff 1974). This research needs to determine some of the following:

1) the importance of urban natural areas, expressed as the number of urban residents utilizing them;
2) the importance of urban natural areas as wildlife habitat, expressed as the species composition and wildlife populations utilizing them;
3) the preferences of users and non-users of urban natural areas for the management of the areas; and
4) the particular behavioural characteristics and natural histories of urban wildlife species in order that they may be better managed in urban environments.

To the present, there has been a relative paucity of urban wildlife research. Some authors have written accounts of natural histories of large cities including New York City (Rublowsky 1967) and London, England (Johnston 1930, Filler 1945). "Some specific topics within the general subject area have been investigated. These topics include lichens in cities, suburban songbird ecology, and control of urban pest species" (Gill and Bonnett 1973). Much of the available information concerning urban wildlife-related research is reviewed by Bonnett (1970) and Gill and Bonnett (1973). Gill and Bonnett (1973), in addition, describe specific methods

for incorporating wildlife into the urban setting and describe guidelines for managing wildlife within urban areas.

The subject has slowly been gaining more exposure. At the Thirty-Second North American Wildlife and Natural Resources Conference (1967), sessions were based on a theme of urban and rural resources. Papers delivered treated the topic of urban wildlife on a broad, theoretical level, attempting to assess and identify the function and role of wildlife in the metropolitan setting (Sheffey 1967). At the same conference, Davey (1967) urged professional wildlife managers to emphasize enhancement of wildlife resources in the urban environment for the reason that the greatest proportion of the United States population inhabited an urban environment. Stearns (1967) stressed the need and opportunities for developing wildlife habitat within urban areas. At the same conference, Twiss (1967) stressed the need for collaboration between wildlife managers, urban designers and planners. McHarg (1969) and Maestro (1974) further stress the need for nature and wildlife to be incorporated into city planning. A series of more precise papers was presented at a symposium on "Wildlife in an Urbanizing Environment (University of Massachusetts 1974).

Additional research concerns of a more definitive nature include the following:

1) wildlife populations in particular urban habitats. Some papers concern annual breeding bird censuses which are

regularly published in ornithological journals (Spiers 1970, Erskine 1971, Fairfield 1971, Nasmith 1971, Tramer 1971). Some of the habitats inventoried include man-made, non-biotic habitats (Galushin 1971);

2) characteristic behavioural traits of wildlife in urban situations. A great deal of this literature concerns the urbanization of birds in Europe (Erz 1963, 1967; Strawinski 1963a, 1963b; Luniak 1965; LeRhun 1967; Tenovva 1967). Particular bird species discussed are tufted ducks (*Aythya fuligula;* Krzanowski 1970); weaver-finches (*Passer domesticus;* Turek 1972); rufous-backed shrikes (*Lanius collurio;* Sheripov 1972); jays (*Garrulus glandaris;* Pfeifer 1972); woodpigeons (*Columba palumbus;* Vehr 1971, Ljungglen 1971, Cramp 1972); and redwing blackbirds (*Agelaius phoeniceus;*[1] Barth 1963);
3) the effect of housing development on bird populations (Erskine 1974, Geis 1974);
4) the adaptation of mammals to urban situations (Gill 1965, 1970; Gill and Bonnett 1973; Flyger 1974; Schinner 1974);
5) wildlife as pests in urban areas (Kuroda 1964, Pearson 1967, Smith 1974, Solman 1974); and
6) the utilization of the urban wildlife resource (Dagg 1970, Milne and Milne 1974, Roth 1974).

---

[1] A list of common and scientific names of bird species mentioned in the text appears as Appendix D.

In 1974, the Canadian Nature Federation based its annual conference on a theme of "Urban Man and Nature," an indication of the increasing concern that nature and urban man can and do co-exist. Papers presented addressed:

1) the effects of freeway development on urban wildlife populations (Spencer 1974);
2) the effect of urban housing densities and tree development on urban bird populations (Erskine 1974);
3) the effect of bicycle paths on urban ravine bird populations (Nasmith 1974); and
4) methods and practices of including nature in urban planning (Dorney 1974).

The conference demonstrated that research had passed the stage of being treated "in a broad theoretical level" (Sheffey 1967) to the stage where definitive research was being carried out in Canada.

The importance of ravines, specifically, as urban natural areas, surfaced at this conference (Hilts 1974, Nasmith 1974, Spencer 1974).

1.2 The Edmonton, Canada Situation

Natural areas in the City of Edmonton occur along ravines that empty into the North Saskatchewan River Valley. The ravines compose much of the city's designated parkland. However, to the city transportation and utility planners, they also offer viable routes for transportation and utility

facilities.

Arguments for using ravines as transportation routes are as follows. Freeways that traverse established neighbourhoods are reputed to disrupt the traditional neighbourhood patterns (Jacobs 1970) and there are certain inherent disadvantages in expropriating property from urban residents in order to construct freeways. Ravine parkland in Edmonton is city-owned and this situation removes the necessity for large amounts of property expropriation for freeway right-of-ways.

Those who recognize the advantage of ravines as recreation areas object to the ravines being put to intensive uses such as freeways. The opposition to freeways in cities is not new. In Toronto, organized opposition was successful in halting the Spadina Freeway when it was only partly finished.

Freeways may not solve transportation difficulties. In Boston, because of the concern over freeway development, a full social, economic and environmental impact assessment was made of the freeway system (David Crane and Associates 1972). The assessment found the freeway system to be unsuitable so the project was scrapped. Similar opposition has surfaced in Edmonton, where some citizens have for several years opposed a proposed Jasper Freeway through the Mackinnon Ravine. Chief opposition came originally from a "Save the Parks" organization but has received a wider base

of support from persons opposed to it for the following reasons:

1) the ravines are, from a geo-technical point of view, unstable and susceptible to slumping;
2) the ravines are an important part of the city parks and recreation program;
3) the ravines should be preserved because they are useful as natural areas; and
4) rapid transit is a more viable alternative to Edmonton's transportation problems than are freeway systems.

The Edmonton River Valley ravines are characteristically narrow and may not be capable of supporting both freeways and recreational uses. The ravines are an important resource for non-consumptive wildlife uses such as the observation and study of wildlife, and freeway development may reduce or eliminate this potential.

Little base-line information concerning the species composition and populations of wildlife inhabiting the Edmonton ravines exists, although work is under way to publish wildlife lists for the Edmonton region (R. Ebel pers. comm.). Some reference to the existence of wildlife in the ravines is made by Proudfoot (1965). This study also describes the recreational importance of the Edmonton North Saskatchewan River Valley, but it does not provide detailed information about the use of the tributary ravines or of their wildlife resource. Neither was information collected

about the preference of citizens for the management of the ravines.

1.3 Statement of Objectives

Information is needed on species composition and wildlife populations in ravine areas; the effect of road development on these; the number of persons utilizing the ravine areas for recreation, particularly wildlife-based; and the management preferences of citizens for ravines. This would provide base-line data on:

1) the recreational potential and importance of the ravines that could be included in analyses of alternate uses for the ravines;
2) the importance of the ravines as wildlife habitat;
3) the impact of urban development on wildlife; and
4) how the ravines could be better managed for wildlife.

To achieve these general objectives, biological and recreational investigations of four City of Edmonton ravines were initiated in the summer of 1972.

During late summer and early autumn of 1972, ravine habitats were defined and preliminary maps delineating their boundaries compiled. Sample habitat plots were also selected for field investigations.

Systematic investigations for wildlife in the ravines began in January 1973 (winter season) and concluded in July 1973 (summer season).

During May and June of 1973, a questionnaire survey was conducted in sample residential areas in the vicinities of the study ravines.

CHAPTER 2

SITE DESCRIPTION

2.1 Edmonton Area

2.1.1 Location

Edmonton is located in central Alberta, Canada, between 113°00' and 114°00' W longitude and 53°15' and 53°45' N latitude (Figure 1).

2.1.2 History

Fort Edmonton was established at the junction of the North Saskatchewan and Sturgeon Rivers by William Townsend in 1795 to serve the fur-trapping industry in the North Saskatchewan and Athabasca River drainages. The city's history is discussed by Proudfoot (1965) and MacGregor (1967). Proudfoot also discusses the historical importance of the North Saskatchewan River Valley to Edmonton and the historical development of the river valley parks system.

2.1.3 Climate

Edmonton has a Dfb climate (Strahler 1969). The coldest month average temperature is -14.85°C and the average temperature of the warmest month is 15.95°C. There is precipitation in all months with no dry season. The summer is warm, the warmest month being below 22°C. Table 1 shows

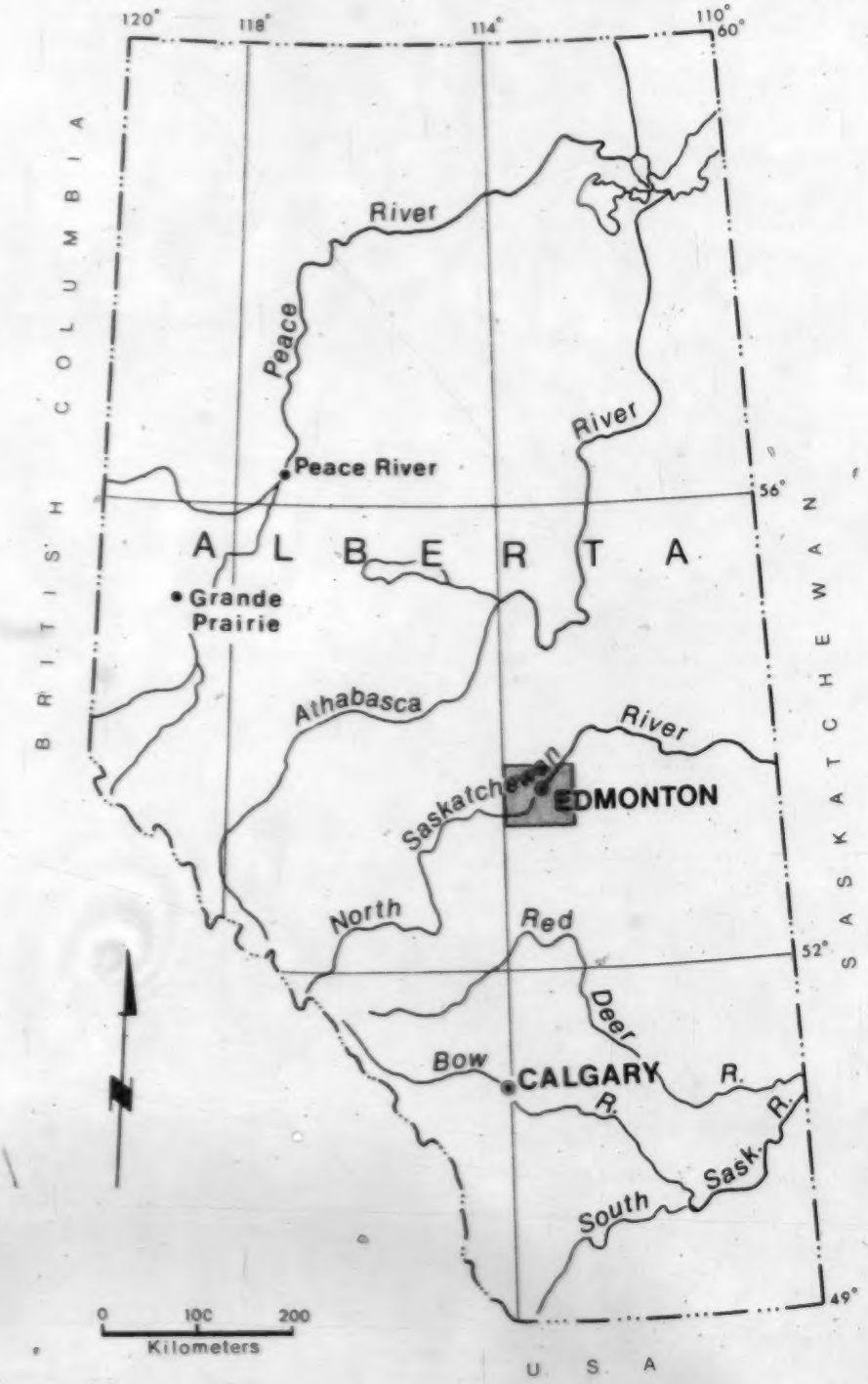

FIGURE 1

LOCATION OF EDMONTON

TABLE 1

TEMPERATURE AND PRECIPITATION IN EDMONTON

	Degrees C	Centimetres
Mean January Temperature	-14.85	
Mean April Temperature	2.2	
Mean July Temperature	15.95	
Mean October Temperature	4.95	
Mean Spring Precipitation		15.24
Mean Summer Precipitation		22.86
Mean Autumn Precipitation		8.89
Mean Winter Snowfall		132.08

Source: Proudfoot (1965)

some statistics for mean temperature and precipitation in Edmonton.

2.1.4 Surficial Geology

Bayrock and Hughes (1962), Carlson (1966), McPherson and Kathol (1972, 1973) and Bayrock (1973) describe the surficial geology of the Edmonton district. The area experienced continental glaciation during the Wisconsin period. During deglaciation, glacial Lake Edmonton was formed which later drained through the Gwynn outlet, southeast of the city. Edmonton now lies on the lacustrine plain of glacial Lake Edmonton.

The North Saskatchewan River existed prior to glaciation and became re-established after deglaciation by cutting through the lake sediments where Edmonton now exists.

The North Saskatchewan River Valley can be divided into two sections. Upstream from the Clover Bar Bridge (Figure 2) the valley rarely exceeds 1609 m in width, and the nearly vertical valley walls average 61 m in height. Downstream from Clover Bar Bridge, the valley widens to 2.5-3.25 km and the valley walls average 38 m in height (Bayrock and Hughes 1962).

The tributary ravines result from post-glacial drainage to the main river from wetlands and lakes of the upland areas (Erxleben 1972).

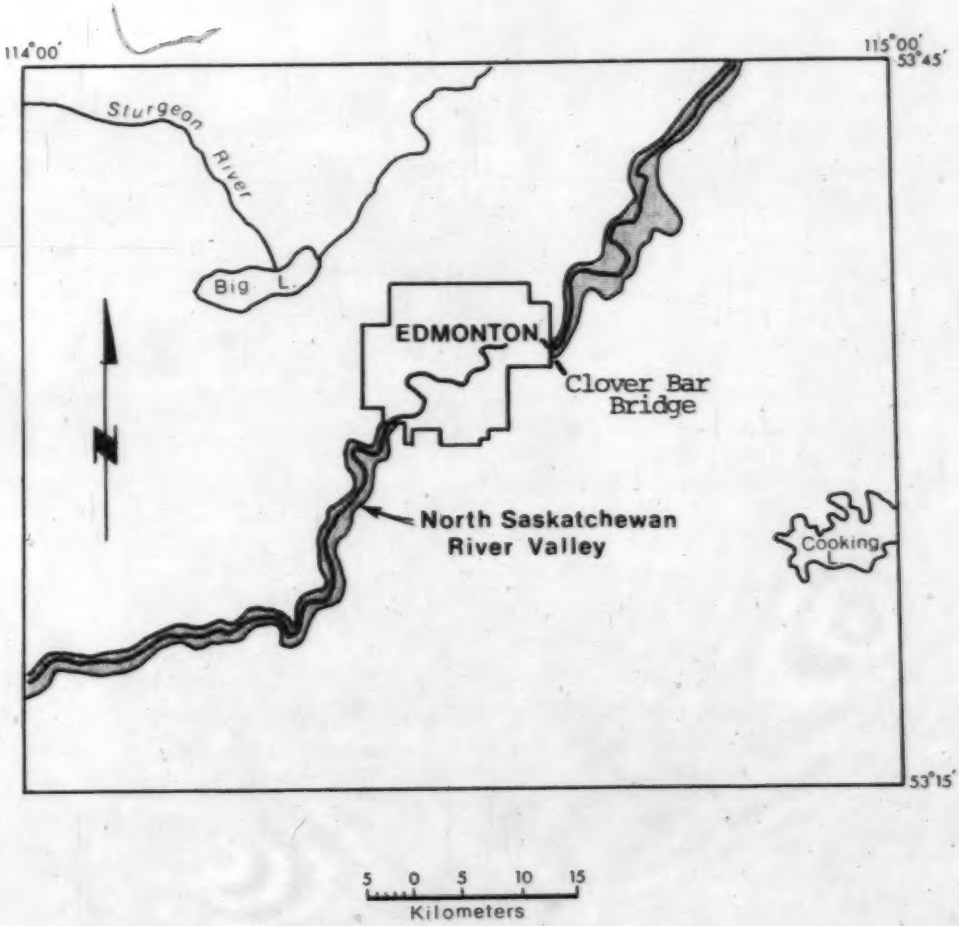

FIGURE 2

NORTH SASKATCHEWAN RIVER VALLEY

The unstable walls of the creek valleys are mantled by colluvial sand, silt and clay. Slumps and landslides are common (Bayrock and Hughes 1962).

2.1.5 Bedrock Geology

The bedrock of the Edmonton area is composed of Upper Cretaceous shales, shaly sandstones and sandstones belonging to three formations, all dipping at about 3.75 m per km to the southwest. These formations are the Edmonton, the Bearpaw and the Belly River. The Edmonton formation underlies most of the Edmonton district. It is composed of interbedded bentonitic shales and sandstones with some coal seams (Bayrock and Hughes 1962).

2.1.6 Soils

Bowser et al. (1962) describe in detail the soils of the Edmonton region.

Soils are formed principally from lacustrine deposits of glacial Lake Edmonton which were derived from Upper Cretaceous sedimentary bedrock. Soils are classed as chernozemic, grey wooded, dark grey and dark grey wooded (Erxleben 1972). On Saskatchewan River Valley terraces, and within the tributary ravine valleys, soils are regosolic, and display an overall immaturity.

2.1.7 Vegetation

Edmonton lies within the aspen parkland region, which is transitional from the prairie to the boreal forest (Bird 1961, LaRoi 1967). Rowe (1972) includes Edmonton in the forest and grassland section of the Boreal Forest Region. Within the city, the North Saskatchewan River Valley and its tributary ravines support a diversity of plant communities. There are dense stands of white spruce (*Picea glauca*)[2] and boreal mixed wood composed of white spruce-white birch (*Betula papyrifera*), white spruce-balsam poplar (*Populus balsamifera*), and white spruce-trembling aspen (*Populus tremuloides*) associations. There are open slopes dominated by stands of shrubs and by grass and forb communities.

2.2 Description of Ravine Study Areas

Four river valley ravines were selected for biological inventory and recreational study. The ravines chosen for their varying degrees of road development were: Mackinnon, Mill Creek, Whitemud Creek and Groat Road Ravines. The hypothesis tested was that the degree of freeway development negatively influences wildlife populations in the ravines. It was expected that smaller and less diverse wildlife populations would be present in the ravines with the most freeway development, particularly Groat Road Ravine.

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[2] A list of common and scientific names for all plant species mentioned in the text appears as Appendix E.

2.2.1 Mackinnon Ravine

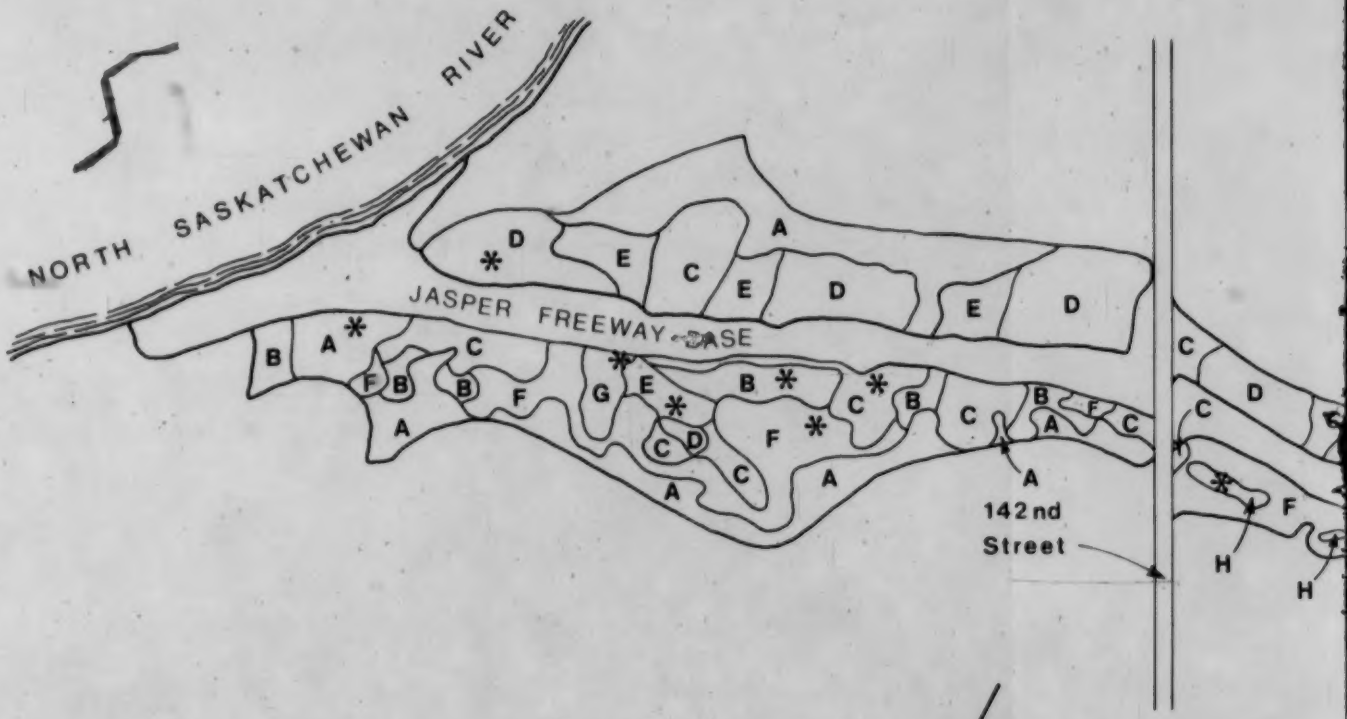
Mackinnon Ravine in west Edmonton is a tributary to the north side of the main river valley. It is 1.56 km long. Before the bottom was filled as a base for a proposed freeway (Jasper Freeway), the ravine was approximately 50 m deep near its confluence with the North Saskatchewan River and was occupied by an intermittent stream.

As in the main river valley, there are growths of dense spruce and mixed wood forests as well as areas occupied by grass and shrub communities. Before the ravine bottom was filled, it was occupied by a mature, mixed wood forest similar to that now found in the bottom-land of other local streams such as Whitemud Creek Valley. The freeway base supports a growth of pioneer forb species (Plate 1).

One bridge traverses the ravine at 142nd Street (Figure 3). The ravine rim is lined with single-family detached dwellings. No planned recreational facilities exist but skiers, tobogganers, motorcyclists, and operators of four wheel drive vehicles utilize the ravine slopes. The ravine bottom is used by cross-country skiers, snowshoers, cyclists, and casual walkers.

Boundaries for the study of this ravine extend from the ravine's beginning at 149th Street to its confluence with the North Saskatchewan River (Figure 3).

Plate 1. Vegetation on freeway base, Mackinnon Ravine.



– KEY –

- **A** Grassland
- **B** Shrubland
- **C** White Spruce – Poplar
- **D** White Spruce – White Birch
- **E** White Spruce
- **F** Poplar
- **G** Poplar – White Birch
- **H** Dead Tree
- ✻ Denotes sample plot location

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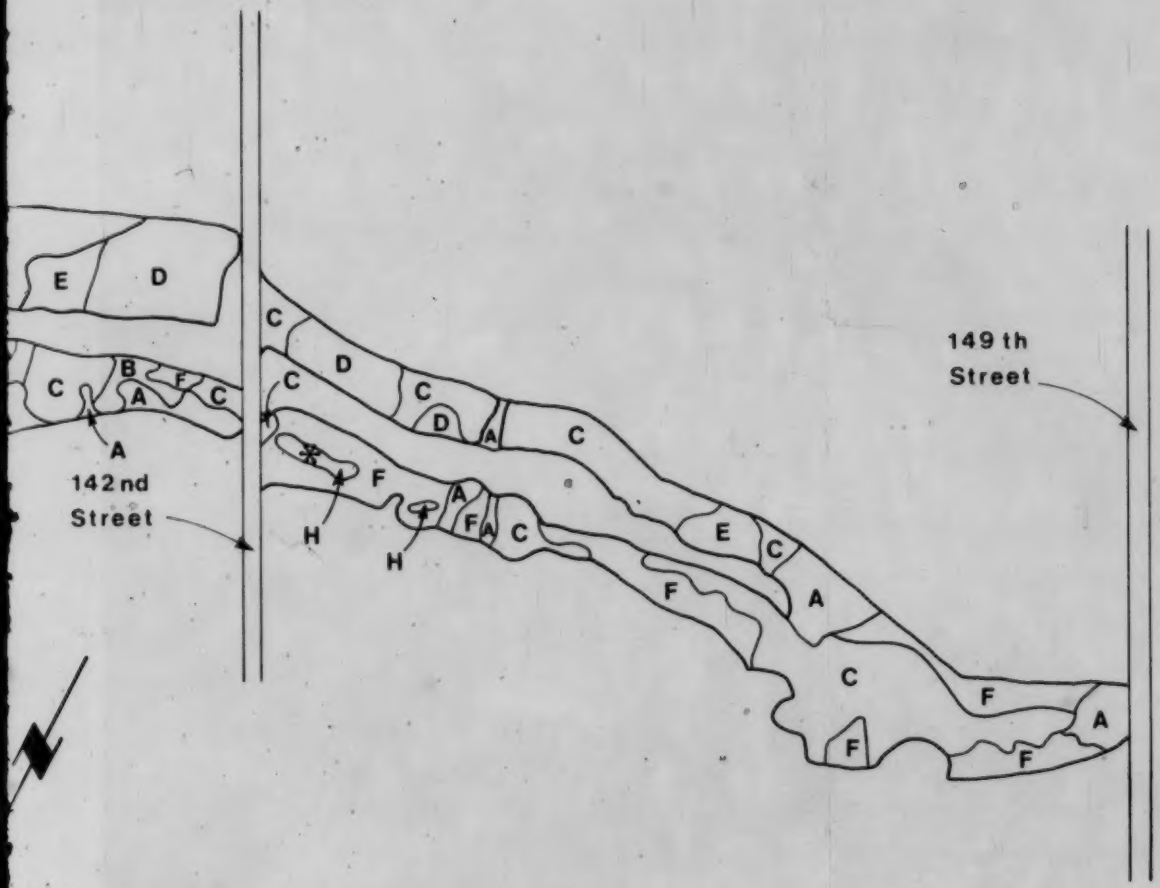

FIGURE 3
MACKINNON RAVINE
Habitats and habitat sample plots

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2.2.2 Mill Creek Ravine

Mill Creek Ravine enters the south side of the North Saskatchewan River Valley opposite the central business district (cbd) (Figure 4). From its beginning to the confluence, the ravine is approximately 8 km long, and its greatest depth is approximately 46 m. An intermittent stream flows through the valley. Because of urban developments such as the construction of storm sewers, the creek runs high for short periods during spring snowmelt and following rainfalls.

The ravine bottom is largely occupied by stands of riparian balsam poplar and willow (*Salix spp.*), except for a few areas which are home sites.

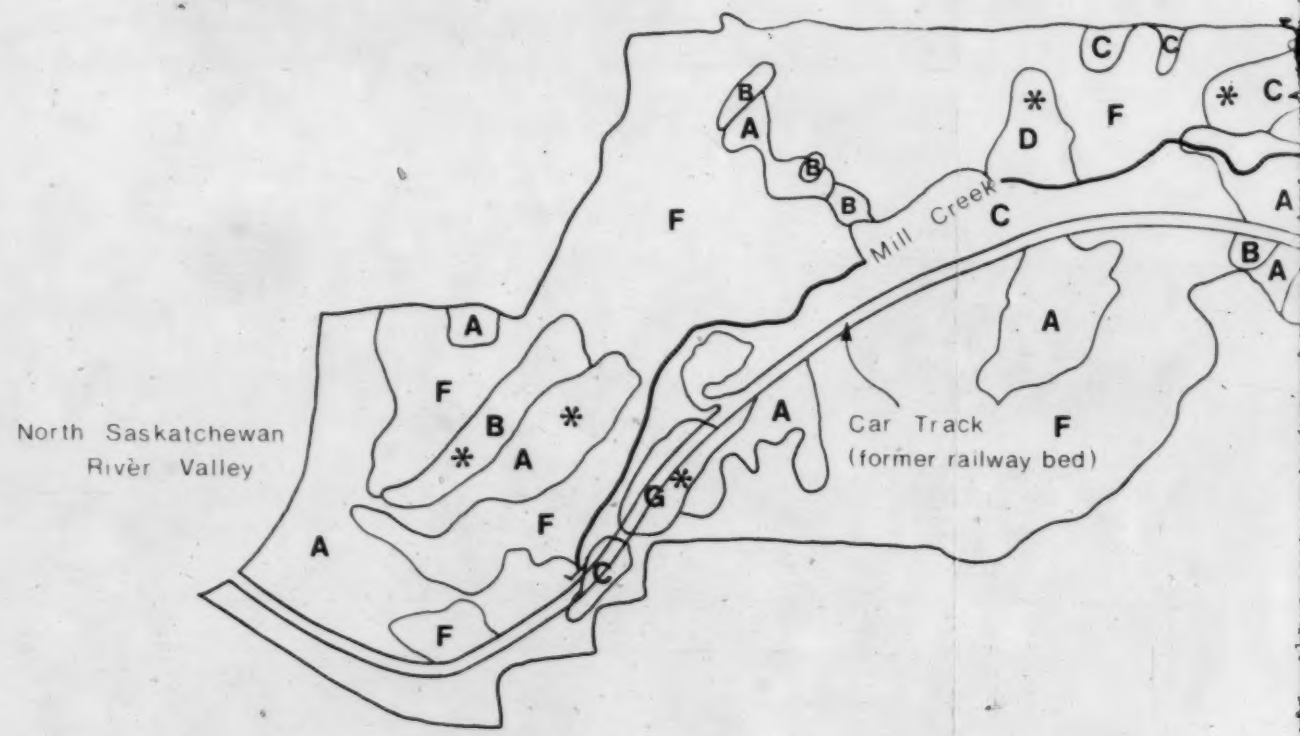
The study area of this ravine is a section approximately 2 km long, from 82nd Avenue to the ravine's confluence with the main river valley (Figure 4). Within the study area one road dips into the ravine, and crosses the creek bed. An old railroad bed, presently used as an automobile track, runs along the west bank of the ravine.

An access road from 82nd Avenue leads to the Mill Creek swimming pool complex. In addition to the swimming pool complex, there are picnic tables on the floor of the ravine. These picnic sites are used in summer by the Parks and Recreation Department for their day camp program.

The study area is bordered by single-family detached homes, generally 25-30 years or older.

– KEY –

- **A** Grassland
- **B** Shrubland
- **C** White Spruce – Poplar
- **D** White Spruce – White Birch
- **E** White Spruce
- **F** Poplar
- **G** Poplar – White Birch
- **H** Dead Tree
- ✻ Denotes sample plot location



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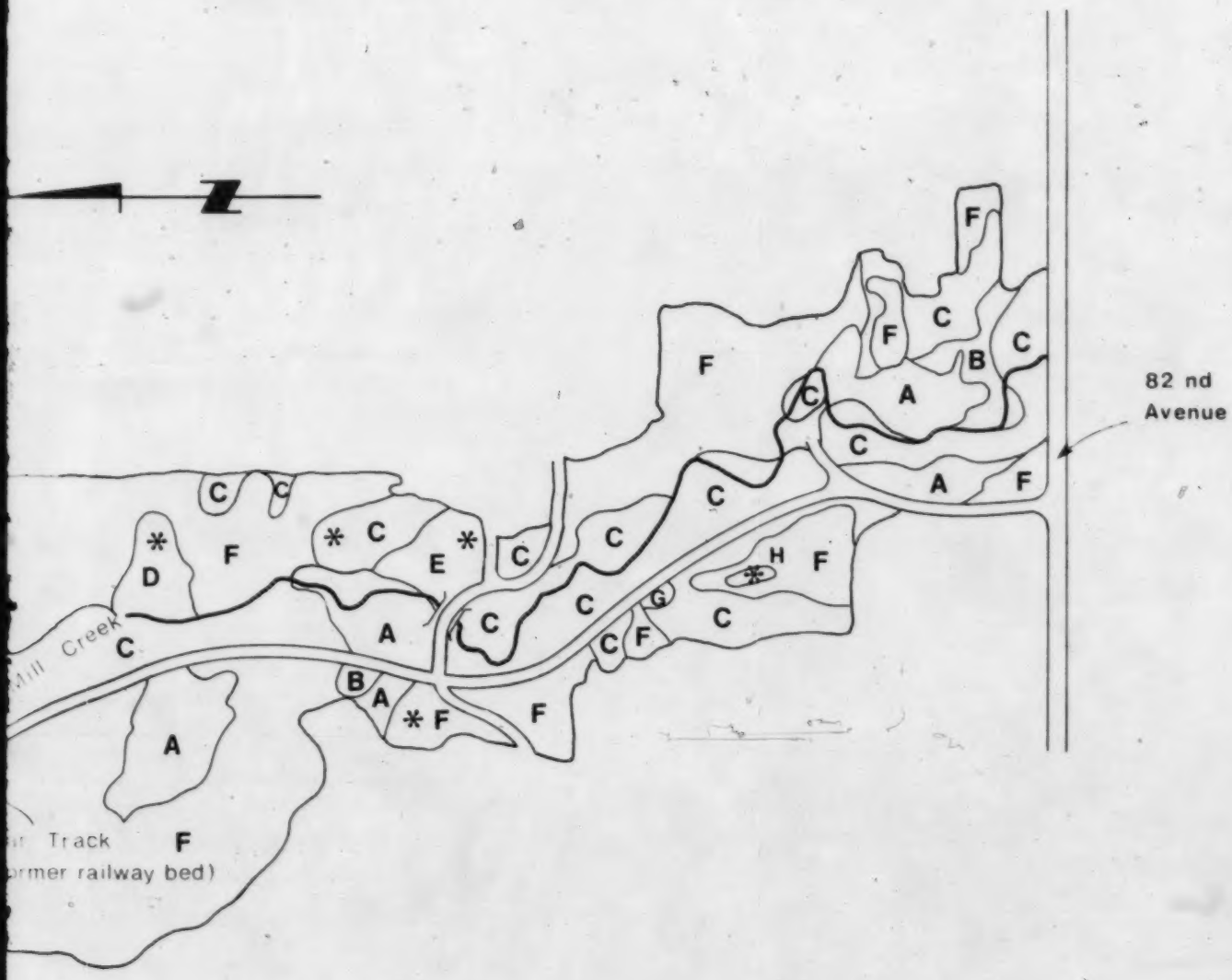

FIGURE 4
MILL CREEK RAVINE
Habitats and habitat sample plots

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2.2.3 Whitemud Creek Ravine

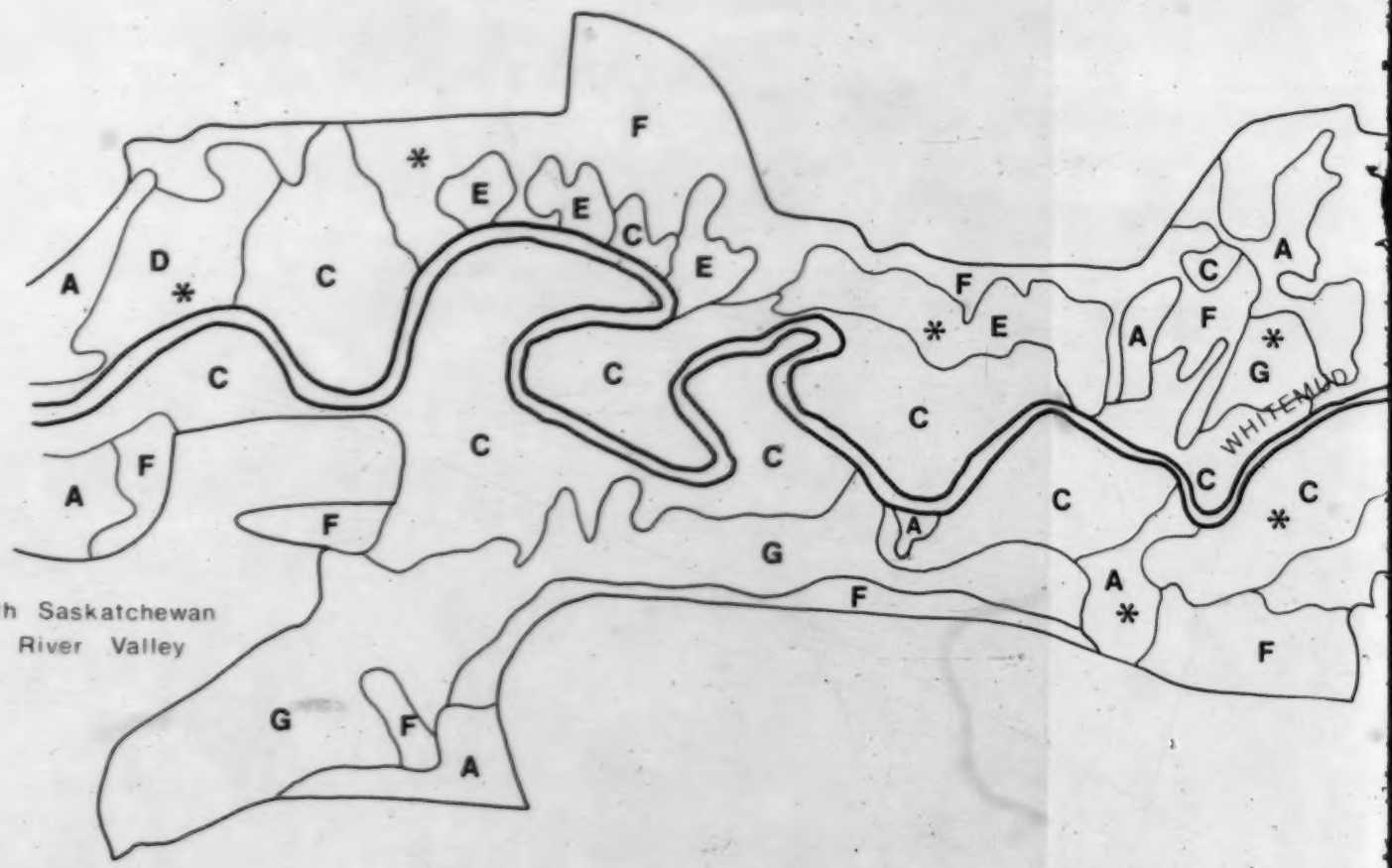
The Whitemud Creek drainage basin lies on the south side of Edmonton. Resulting largely from increased infiltration within its drainage basin because of intense agriculture, Whitemud Creek is intermittent and experiences peak flows during spring runoff and for brief periods following summer rainfalls (Alberta Environment 1973). Water quality in the creek is poor and in winter has dangerously low oxygen contents for fish. Detailed information on the hydrology of Whitemud is given by Raines (1969) and Erxleben (1972).

Vegetation patterns in the ravine are similar to those in the other study ravines. The valley floor, however, is occupied by a mature white spruce-balsam poplar forest.

The ravine study area is wider than the others and has the least road development. The study area boundaries are 45th Avenue and the confluence with the North Saskatchewan River Valley (Figure 5). No roads exist other than at the north and south extremities where recreation centres are located. At the south end of the study area there is a ski hill and lodge and a tent park. At the north confluence there is a ski hill and lodge and picnic sites along the creek. Well-established nature trails run the length of the study area. In winter, the creek is dammed near the confluence and the resulting temporary reservoir is used for public skating. The City Parks and Recreation Department

– KEY –

- A Grassland
- B Shrubland
- C White Spruce – Poplar
- D White Spruce – White Birch
- E White Spruce
- F Poplar
- G Poplar – White Birch
- H Dead Tree
- * Denotes sample plot location



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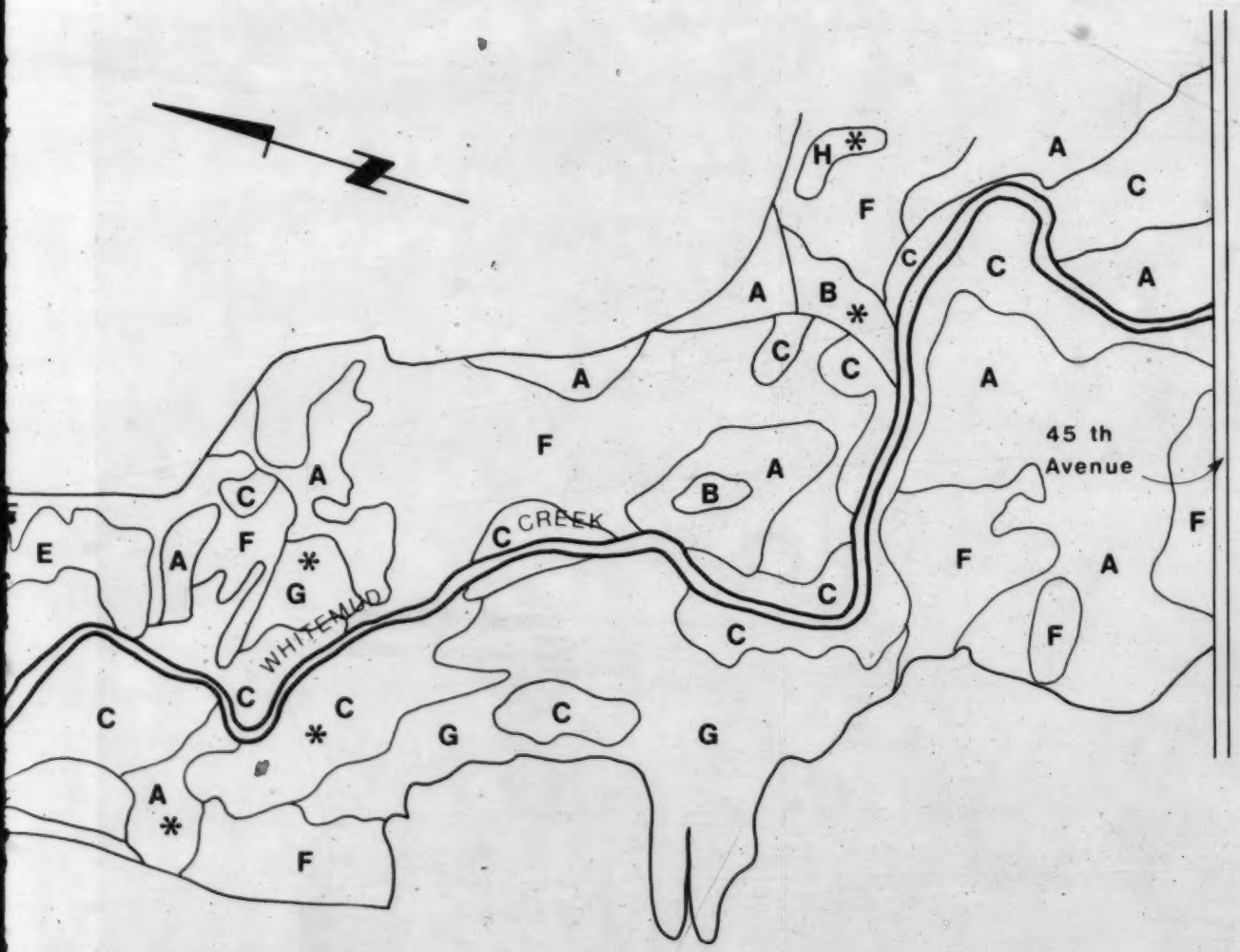

FIGURE 5
WHITEMUD CREEK RAVINE

Habitat and habitat sample plots

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operates a day camp program in the ravine during summer, and organized nature walks originate at the lodge at the north end.

The ravine is lined with newer, expensive, single-family detached homes.

2.2.4 Groat Road Ravine

Groat Ravine is approximately 1143 m long and enters the main river valley in west-central Edmonton. It is approximately 198 m at its widest point and 34 m at its deepest location. The ravine floor was one of Edmonton's original river valley parks (10 ha, 1912; Proudfoot 1965) but now it is occupied by a four-lane major arterial.

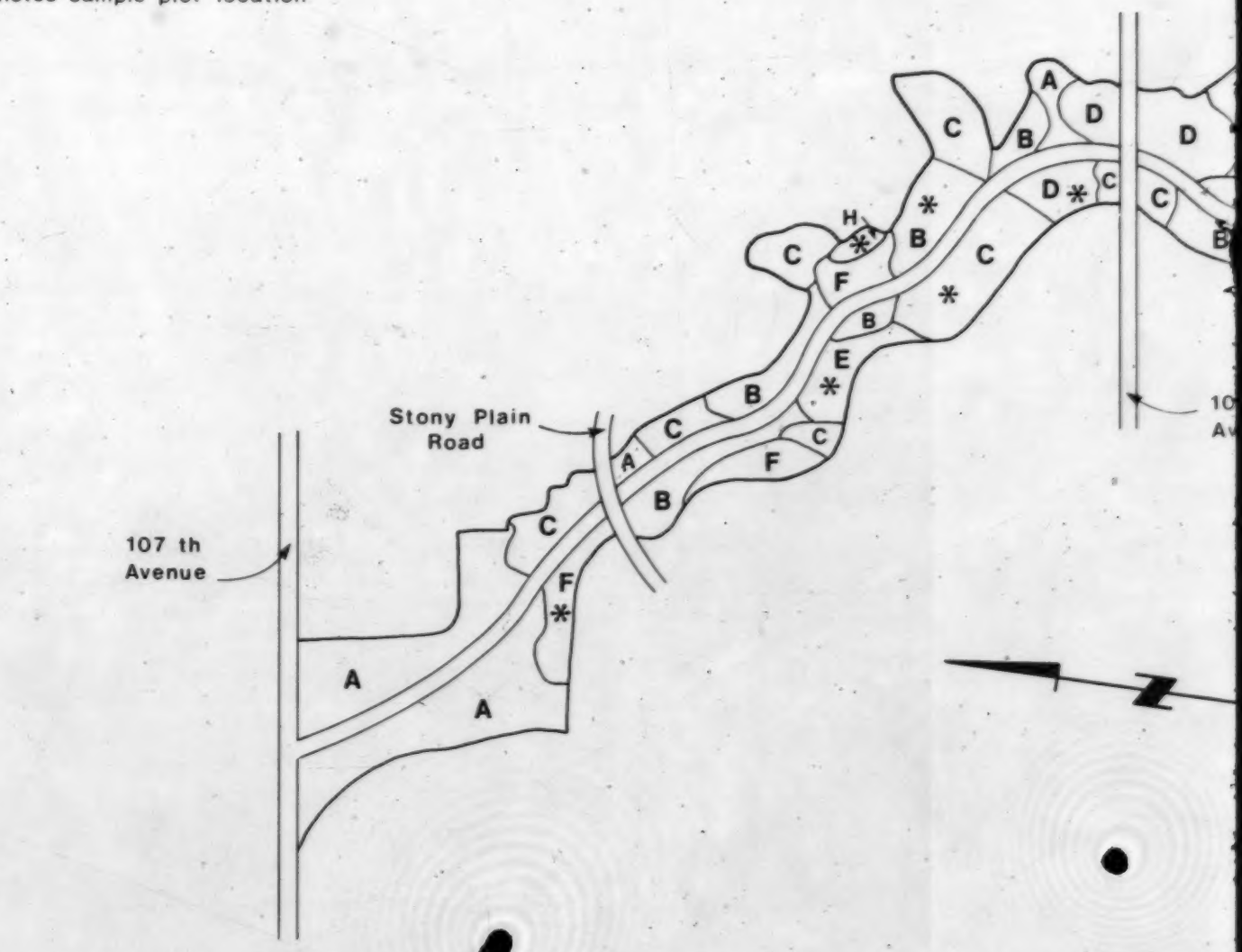
Because this ravine, like Mackinnon, is short, the entire ravine composes the study area (Figure 6). Two bridges cross the ravine, and both are busy city arterials.

Although there is a self-developed bicycle path on the west bank of the valley, there are no established recreational facilities in the ravine. At the confluence, however, there is a well-known tobogganing and hang-gliding hill that receives year round use. At the base of the hill next to the river is a picnic area.

The valley is bordered by older, well-established, single-detached dwellings and a few old mansions.

– KEY –

- **A** Grassland
- **B** Shrubland
- **C** White Spruce–Poplar
- **D** White Spruce–White Birch
- **E** White Spruce
- **F** Poplar
- **G** Poplar–White Birch
- **H** Dead Tree
- ✱ Denotes sample plot location



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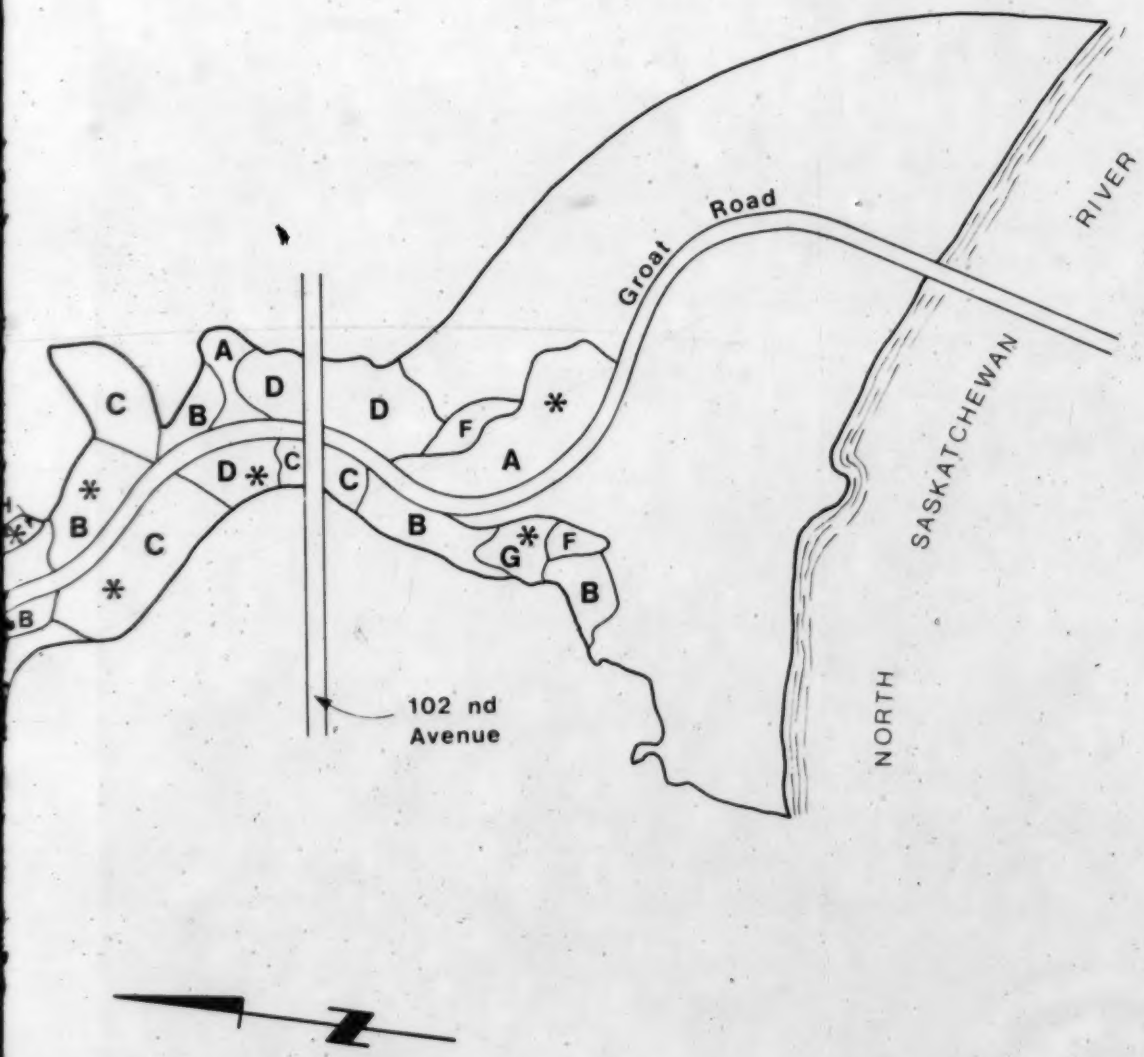

FIGURE 6
GROAT RAVINE
Habitats and habitat sample plots

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COLOUR

CHAPTER 3

METHODS

3.1 Biological Inventory

3.1.1 Habitat Mapping

Initially, a study area in each of the four ravines was delineated. For logistical reasons, only the lower sections of Mill Creek and Whitemud Creek Ravines were included. The lower reaches were studied because:

1) they would most closely duplicate the conditions of the other two ravines in being more adjacent to the main river valley;
2) studying the lower section of Mill Creek Ravine introduced the influence of the central business district on wildlife; and
3) the upper parts of Whitemud Creek are adjacent to cultivated fields and a sparsely populated area which would have introduced a rural bias to an urban-oriented study.

Habitats in the study areas were delineated and mapped by examining both 1 inch--500 feet vertical aerial photographs and 1 inch--200 feet base maps provided by the City of Edmonton Parks and Recreation Department. Ground truthing allowed a precise identification of habitat types and ecotones.

Following the identification and mapping of habitats for each of the ravines, an approximately 3000 m^2 sample plot for each of the eight habitat classifications was randomly selected in each study area for further biological investigation.

3.1.2 Vegetation Analysis of Sample Plots

A method of habitat analysis was required that would provide information about cover density and the plant species making up the cover. "Cover" is defined as the vertical projection of above ground parts onto the ground (Giles 1969). Webb (1942) suggested a measure of cover density (ocularly estimated) based on the amount of the sample unit covered by the leaves of the cover components (overstory, understory, ground cover).

Line transects are a standard method for sampling plant communities (Kuchler 1967, Giles 1969, Cain and deCastro 1959). Species that shade or touch the transect are included in the sample.

In this study, a method was employed that combined a sampling of plant species with a technique for measuring cover. The two dominant and most common overstory species in a plant community were used as indicators of habitats except for those which were better described by other means. Thus areas of grasses, sedges and forbs are referred to as "grassland" habitat, and areas of shrubs as "shrubland."

Age or successional stage was not used in the classification. An area of youthful, 5 m tall balsam poplars and another of mature, 20 m tall balsam poplars are both classified as "poplar" habitat. Ecotone boundaries and a habitat map were compiled after Küchler (1967).

For the purposes of this study, trembling aspen and balsam poplar were both included in the poplar habitat classification. These species, in many cases, are found in association in the ravines. To include the two species as separate habitats would have resulted in an impractical number of habitat ecotones for the purposes of this study.

In total, two sample plots of each of the habitats with tree cover and two of each of the shrubland plots were sampled in the following manner:

1) a 30 m sample transect was run along the habitat floor;
2) for both the overstory and understory, all plants that touched or shaded the transect were identified;
3) the horizontal distance of cover that each species provided along the sample transect was recorded;
4) from the above measurements, the percentage of the overstory cover that each species provided was determined and also the portion of the total understory cover that the understory species provided; and
5) the percentages of total overstory cover and total understory cover were determined.

This method was employed in order to detect differences in

the distribution of coverage and plant species in the sample plots. Information gained provides general information about the characteristics of vegetative cover in the various habitats.

In addition to the information about cover and plant species in the habitat plots, information about slope and aspect was recorded.

Cover and vegetation analyses, as described above, were not conducted in the "grassland" or "dead tree plots." In the grassland plots, only plant species present in the plot were identified. There was likely to be a great deal of variance in the sample plot vegetation compositions as some plots were artificially cultivated. Only ocular estimations of the percentage frequency distribution of plant species present were made. "Dead tree" plots were not sampled as they had been established primarily to measure the extent of their use by birds for perching.

3.1.3 Inventory of Wildlife Species

With the exception of some data concerning species diversity, all information concerning wildlife populations was collected in the sample habitat plots. Wildlife data were collected in habitat sample plots rather than along sample transects despite the small size of the plots. Reasons for using this technique were:

1) the sample plot was judged to be the best method for collecting combined bird and mammal data;

2) data gained can be more simply extrapolated to square units;
3) plots would be more appropriate for space-time inventories that are useful measurements for a recreation-oriented study.

Enumerating bird populations by the use of sample plots is described by several authors (Enemar 1959, Carbyn 1967, Erskine 1971). Others have described the use of sample plots for mammal population studies (Dice 1931, 1938; Leopold 1933; Bennett et al. 1940; Wilkins 1957).

Sample plots of the present study were, on average, smaller than in most studies, therefore census data more closely represent a combination of plot and point census surveys than an actual plot survey. Sample plots for birds are surveyed during the breeding season when birds exhibit territorial behaviour. Over a period of time, the territories of males are mapped out in the sample plot and population estimates based on the number of territorial males using the plot. The point census survey is described by Howell (1951) and Hall (1964) and is more commonly used for such purposes as enumerating bird migration past a point, or enumerating the number of birds that are detectable from one point.

In this study, birds observed in the sample plots, and observed flying over it during the one-half hour observational session, were counted. This method provided, from

small plots, more raw data for statistical analysis.

In addition, as the study has implications for the recreational appreciation of bird populations, the plot-point census method measures the recreational quality of an outing by counting the number of birds seen during one-half hour spent in a specific habitat.

3.1.3.1 Bird Census Methods

3.1.3.1.1 Bird study plots. A number of authors (Dice 1930, Lay 1938, Goodrum 1940), maintain that data suitable for statistical analysis can be obtained during one-half hour observational sessions in study plots. During the winter of 1972-73, and the spring and summer of 1973, six one-half hour observation sessions were conducted during each of the three seasons in each sample plot. Every sample plot was thus visited 18 times throughout the course of the study. During each visit, the species and their numbers using the plot and airspace above it were recorded. Birds were field identified after Peterson (1969). Although an effort was made to not count the same bird or group of birds more than once, in some instances wider-ranging bird species were probably re-counted. Birds recorded in one plot may also have been re-counted in another plot due to the restrictiveness of linear ravines and the mobility of some species. Red-tailed hawks (*Buteo jamaicensis*) and black-capped chickadees (*Parus atricapillus*), for instance, have large home ranges (Welty 1962).

Observational visits in all seasons were conducted in early daylight hours when birds are most detectable (Welty 1962). In order to eliminate a time bias, the order of visits to plots was rotated each day.

3.1.3.1.2 Statistical treatment of plot-point bird data. Bird data were subjected to an analysis of variance statistical test (BMDO2V) in order to determine if significant differences exist between ravine study areas, habitats within study areas, season, and the interaction between these. In order to meet the requirements of ANOVA, data from the study plot visits were arranged into 16 groups of variables. They were:

1) all birds in winter field season;
2) all birds in spring field season;
3) all birds in summer field season;
4) the sum of all birds in all field seasons;
5) the sum of all birds in all field seasons excluding bohemian waxwings (*Bombycilla garrula*);
6) jays, magpies and crows in winter field season;
7) jays, magpies and crows in spring field season;
8) jays, magpies and crows in summer field season;
9) the sum of jays, magpies and crows in all field seasons;
10) passerines in winter field season;
11) passerines in spring field season;
12) passerines in summer field season;
13) the sum of passerines in all field seasons;

14) the sum of all finches in all field seasons;
15) the sum of all chickadees in all field seasons; and
16) the sum of bohemian waxwings in winter and spring field seasons.

Variables 1-13 were treated using a three-way analysis of variance BMDO2V (Dixon 1968). Variables 14, 15, and 16 were subjected to a BMDO2V two-way analysis of variance factorial design (Dixon 1968).

To apply three-way analysis of variance to variables 1-13, data for each of the field seasons were pooled.

3.1.3.2 Inventory of Gallinaceous Birds

3.1.3.2.1 Ring-necked pheasant (Phasianus colchicus). Different methods were used to inventory gallinaceous birds using the sample plots. The crowing count is a standard method of censusing ring-necked pheasants. Kimball (1949) selected linear routes and established listening posts every linear mile. He reported early morning in spring as the optimum time for conducting crow counts. McLure (1945) utilized roads for crowing counts. Giles (1969) also describes roadside counts for estimating wildlife numbers.

The linear topography of the ravines lent itself to a modification of the linear route (McLure 1945) and roadside count (Kimball 1949) methods. From the ravine floors a count of all crowing cocks within the ravine study areas was made. Each ravine served as a continuous listening post so an absolute count was attempted.

Beginning late in April 1973, crowing counts were conducted in each of the ravines beginning at sunrise as suggested by Kimball (1949). The number of crowing cocks was averaged over two listening sessions in each ravine.

A springer spaniel with pheasant hunting experience was used to flush pheasants for establishing sex ratios by visual observation in each ravine study area. During winter, the optimum time for establishing sex ratios for pheasant populations (Kimball 1949), pheasant groups flushed by the dog were sexed.

3.1.3.2.1 Ruffed grouse (Bonasa umbellus). Petraborg (1953) advocates roadside drumming counts similar to the pheasant crowing count for establishing the status of spring populations of ruffed grouse. In spring, drumming intensity reaches a peak in early morning and evening with a slack period between (Hungerford 1953).

In the first week of May 1973, drum counts were made in each of the ravine study areas. As with the pheasant crowing survey, each ravine served as a continuous listening post so an absolute count was attempted. Counts were conducted in all ravine study areas despite not having previously detected evidence of the birds in Mill Creek and Groat Ravines. Results of the surveys were averaged over two visits.

A method for determination of sex ratios in wildlife populations is the collection of bag data during hunting season in autumn (Eberhardt 1971). In urban areas this method is not possible. Literature reviews must be depended

on where live trapping or bag checks are either impossible or logistically unfeasible.

3.1.3.3. Mammal Census Methods

Methods of determining mammal species and their numbers using the ravine study areas were:

1) one-half hour observation periods using the same sample habitat plots as for the bird censuses. Mammals were counted or evidence of their occurrence was recorded simultaneously with the bird observations. Mammals were detected by their physical appearance, sounds (Goodrum 1940), evidence in the form of dens (Dice 1938), and tracks (Murie 1954). Goodrum (1940) describes time-area censuses for determining numbers of gray squirrels *(Sciurus carolinensis)* in Texas. Red squirrels *(Tamiasciurus hudsonicus)* were one of the more detectable mammals in the ravine study areas, so the one-half hour observational session was adopted.

   Through the time-area counts as described by Goodrum (1940), some approximations of red squirrel densities can be made. To compute the probable number of squirrels for each of the habitat plots where squirrels were known to exist, the largest number of squirrels encountered in any half hour session was interpreted as the number of squirrels inhabiting that plot;

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[3]A list of common and scientific names of mammal species mentioned in the text appears as Appendix F.

2) evidence in the form of tracks, not only in the study plots, but in the ravine study areas. Following fresh snowfalls, plots and ravine study areas were examined for mammal tracks. Tracks were identified by using Murie (1954) as a guide;
3) evidence in the form of dens. Sample habitat plots were examined for dens of burrowing mammals. The use of den sites in establishing species and their numbers is described by Dice (1938), Dozier (1948) and Murie (1954);
4) evidence in the form of scats or fecal pellets. Scats were used to identify species of furbearers (Murie 1954) and the intensity of use they made of some sample plots. More intensive pellet surveys were conducted for snowshoe hare. Bennett et al. (1940) and Cochrane and Staines (1961) describe the importance of pellet group counts to wildlife inventories.

A 929 cm^2 sampling frame was constructed from spruce lath. Following snowmelt in April 1973, selected sample plots in each of the ravine study areas were sampled in the following manner: The sampling frame was randomly tossed about each plot 20 times and pellets within the square were counted. As described by McLulich (1937), the obviously old, bleached out, and badly decomposed pellets were not included in the counts. Only relatively fresh ones were included. Data collected by this sampling procedure were extrapolated to the area of the sample plot

in order to determine an index for intensity of use.

3.2 Recreation Investigations

3.2.1 Questionnaire Distribution

Questionnaires were circulated in the census tracts surrounding each of the study ravines to a stratified random sample of citizens living at increasing distances from the ravines. Data used in stratifying the sample were age, sex and housing type. The stratified random sample method increases the precision in representativeness of the sample (Moser 1971).

Demographic composition of the population surrounding each of the study ravines was determined as follows:

1) census tracts surrounding each of the study ravines were identified from the 1971 Census of Canada (Statistics Canada 1972);
2) for each of the census tracts surrounding a study ravine, data concerning the variables age, sex and housing type were pooled to produce means for the sample area. Divisions established for age were adult and juvenile, and for housing type, single detached or single attached and apartment (high rise or walk-up); and
3) the percentage compositions for each of the above variables were computed for each ravine survey area. Hypothetically, if it was determined by pooling data from the census tracts surrounding Mackinnon Ravine that 75

per cent of the population was male, 35 per cent of the population was juvenile and 20 per cent lived in single detached dwellings, then those quotas were met in questionnaire circulation in that area.

Once the demographic sampling quotas were established, each sample area was further divided into three tiers at increasing distances from the study ravine. The first tier was composed of homes or apartments adjacent to the ravine. Second tiers were located three blocks away and third tiers up to a 1.5 km distant.

Early in May of 1973, the questionnaire was pilot tested to determine its effectiveness. It was thought that a significant number of the ravine users may be young juveniles. To obtain their responses, parental aid would be required. A field assistant distributed the pilot questionnaire to a sample of respondents. In cases that required responses from young juveniles, the help of parents was solicited.

Twenty-five pilot questionnaires were distributed and returned completed. No apparent difficulties arose in questionnaire interpretation and adults indicated their willingness to aid juveniles in questionnaire completion.

Between the end of May 1973 and the beginning of July 1973, the questionnaire survey was conducted. Each of the four survey areas was visited, and dwellings were randomly selected from each of the tiers for interviews. On a block

of dwellings, the questionnaire administrator would begin at the corner dwelling and sample every fourth one. In each tier of the survey areas, sex, age, and housing classification quotas established for the total survey area were met. Fifty respondents were sampled for each of the ravine survey areas.

Questionnaires were left with the respondents for a three day period, after which the completed questionnaires were collected. If questionnaires were still uncompleted after three days, a call-back was made.

3.2.2 Questionnaire Format

The questionnaire was distributed to a stratified random sample of Edmontonians in order to determine:

1) the recreation management preferences for the ravines by users and non-users;
2) the relative popularity of the recreational activities available in the study ravines;
3) the intensity of participation in activities available in the study ravines;
4) the importance of the study ravines as resource base for wildlife-based recreation; and
5) the characteristics of users of the study ravines.

The questionnaire was composed of three main parts (Appendix B). The first part was a management preference questionnaire, the results to be analyzed using a Likkert Scale, a method successfully employed by outdoor recreation

researchers in the U.S. Pacific Northwest (Hendee 1968). In Canada, a similar management preference questionnaire was employed by Saskatchewan researchers to determine preferences for bird management (Schweitzer et al. 1973). Respondents indicate their preferences, even though they may not be users of the resource. They are asked to assume idealized conditions represented by such opportunities as ready access and available time. Respondents assume availability of certain activities although they may not be presently available in some ravines. Statements about wildlife-based outdoor recreation were presented in order that the ravines' popularity for non-wildlife-based recreations could be compared. The respondents were also provided with statements about recreation that involves wildlife activities such as viewing wildlife in zoos. These statements were to aid in determining the relative popularity of wildlife-based ravine recreation.

The second part of the questionnaire determined the actual uses the study ravines received as opposed to the preferential uses that they might receive as indicated in Part I.

Part III determined demographic data concerning respondents.

The prime objective of the questionnaire was to provide data useful for management of the ravine areas.

CHAPTER 4

RESULTS

4.1 Biological Investigations

4.1.1 Habitat Mapping

Eight habitat types were identified: grassland, shrubland, white spruce-poplar, white spruce-white birch, white spruce, poplar, poplar-birch, and "dead tree" (Plates 2 to 9). Ravine study area boundaries and the locations of the various habitat types are shown in Figures 3 to 6.

4.1.2 Vegetation Analysis of Sample Plots

4.1.2.1 Grassland

Grassland habitat occurs mainly on steep south-facing slopes, especially where the surface has been disturbed for pipelines, freeways or bridge construction. Species making up grassland habitat are sometimes the result of revegetation programs. Slopes in some cases were terraced to inhibit erosion.

Other areas classified as grassland are planted mixtures of lawn grass along freeway boulevards. In other locations, grassland is naturally occurring.

Ocular estimations (Giles 1969) of the relative abundance of species present in the Groat Ravine sample plot

Plate 2. Grassland type habitat (Mackinnon Ravine).

Plate 3. Shrubland type habitat (Groat Ravine).

Plate 4. White spruce type habitat (Mill Creek Ravine).

Plate 5. White spruce-poplar type habitat (Mill Creek Ravine).

Plate 6. White spruce-white birch type habitat (Groat Ravine).

Plate 7. Poplar type habitat (Mackinnon Ravine).

Plate 8. Poplar-white birch type habitat (Mill Creek Ravine).

Plate 9. Dead tree type habitat (Groat Ravine).

indicated that brome grasses (*Bromus* spp.), white sweet clover (*Melilotus alba*), northern bedstraw (*Galium boreale*), goatsbeard (*Tragopogon dubius*), wild vetch (*Vicia americana*), wild lupine (*Lupinus argentus*), and thistle (*Cirsium* spp.) made up equal proportions of about 90 per cent of the total plant cover in the plot. Less frequently occurring species composing the remaining 10 per cent of the cover included rose (*Rosa* spp.), saskatoon berry (*Amelanchier alnifolia*), and silver berry (*Elaeaganus commutata*)(Appendix C).

Estimations in Whitemud Creek Ravine grassland plot indicated that brome grasses, vetches, annual hawksbeard (*Crepis tectorum*) and northern bedstraw composed equal proportions of about 80 per cent of the total cover. Silver berry (10 per cent), rose, balsam poplar, trembling aspen and white spruce saplings provided lesser amounts of cover.

In all grassland plots investigated, there was evidence of succession at the plot edges to forest or shrubland habitat types. Successional tree species were principally balsam poplar, trembling aspen and white spruce, while shrubs were silver berry and saskatoon.

4.1.2.2 Shrubland

Shrubland habitat occurs in similar environmental conditions as grassland habitat, specifically on dry, south-facing slopes.

Species composition in the Whitemud and Mackinnon shrubland plots showed the following differences. In the Whitemud plot, snowberry (*Symphoricarpos albus*) provided most of the cover (57 per cent), while saskatoon provided the majority of cover (48 per cent) in Mackinnon. Choke-cherry (*Prunus virginiana*), rose and round-leaved hawthorne (*Crataegus chrysocarpa*) were absent from the Whitemud plot but present in the Mackinnon plot (Appendix C). The Mackinnon plot had more total cover (56.5 per cent) than did the Whitemud plot (45.5 per cent). More grasses were present in the Whitemud plot.

Presence of immature balsam poplar and white spruce in the Groat Road plot indicate that this plot is succeeding to forest.

4.1.2.3 White Spruce

Pure stands of white spruce cover small areas. Cool, moist, north-facing slopes are favoured locations. Commonly, white spruce had succeeded white spruce-birch associations as evidenced by dead birch trees in the spruce stands.

The tree layer in the white spruce plots is composed almost totally of white spruce although in the Groat Ravine plot there were few balsam poplar. The Mackinnon plot had a tree layer with a 50 per cent cover and the Mill Creek plot had a tree layer with a 66 per cent cover. Understory was sparse in these and other plots (Mackinnon Ravine 11 per

cent cover and Mill Creek Ravine 15 per cent cover). In the Mill Creek plot, 41 per cent of the understory coverage was provided by red osier dogwood (*Cornus stolonifera*) and in the Mackinnon plot some 67 per cent of the understory was provided by mountain ash (*Sorbus scopulina*). The floor of these plots was composed of needle-leaf litter and small patches of moss.

4.1.2.4 White Spruce-Poplar

White spruce-poplar is the most common of the mixed wood forest habitat types. This type occupies valley bottoms and a variety of slope aspects including west and east. More commonly, the poplar components of the association are balsam poplar.

The Whitemud plot had a tree layer with a 72 per cent cover and the Groat plot had a 60 per cent cover. In the Groat plot most cover was provided by balsam poplar and in the Whitemud plot, most cover was provided by white spruce. The Groat plot had an understory with a cover of 58 per cent and the Whitemud plot had an understory of 63 per cent. In both plots, most understory cover was provided by beaked hazelnut (*Corylus* spp.) and red osier dogwood. Beaked hazelnut provided 44 per cent of the understory cover in Groat Ravine and approximately 37 per cent in the Whitemud plot (Appendix C).

4.1.2.5 White Spruce-White Birch

White spruce-white birch was present along old stream terraces, and on east- and west-facing slopes. It was the least common of the mixed wood forest associations. Where it represented near climax stages of succession, many of the birch were dead. In other instances, the birch were vigorous and not fully matured.

In the Mill Creek plot, the tree layer provided 66 per cent cover and in the Whitemud plot, approximately 79 per cent cover. In both plots, white birch provided most of the overstory cover. In the Whitemud plot the understory had a cover of approximately 67 per cent and in the Mill Creek plot approximately 47 per cent.

Species providing the most understory in the Whitemud plot were willow (40 per cent), red osier dogwood (12 per cent) and pin cherry (*Prunus pennsylvanica*)(11 per cent). In the Mill Creek plot, saskatoon (18 percent, red osier dogwood (16 per cent), and silver berry (16 per cent) provided the most understory cover. Other data are shown in Appendix C.

4.1.2.6 Poplar

A large proportion of the ravine study areas is covered by poplar habitat, made up of balsam poplar or trembling aspen or both. It occurs in various age classes, and is especially common along the ravine peripheries and on

flatter land such as river terraces and flood plains.

The Mackinnon plot was covered by an overstory of 62 per cent while the Groat plot had a cover of 78 per cent. In the Groat plot, most of the overstory was provided by trembling aspen and in Mackinnon Ravine most by balsam poplar.

The understory of the Mackinnon plot had a 95 per cent cover and in the Groat plot, approximately 66 per cent. In the Groat plot, species that provided the most understory cover were saskatoon (42 per cent) and beaked hazelnut (30 per cent). In the Mackinnon plot, willow (50 per cent) and red osier dogwood (18 per cent) provided the most cover (Appendix C).

4.1.2.7 Poplar-White Birch

Not widely distributed, poplar-white birch habitat existed mainly on southeasterly slopes. In all cases, both the white birch and poplar components were vigorous. In almost all cases the poplar component dominated, and the white birch was scattered irregularly through the stands. Usually balsam poplar was more prevalent than trembling aspen.

The Whitemud plot was 71 per cent covered by a tree layer and the Mackinnon plot 62 percent covered. In the Whitemud plot aspen and balsam poplar provided most of the cover while birch provided the most overstory in the Mackinnon plot.

The understory of the Whitemud plot had a 70 per cent cover and the Mackinnon plot 79 per cent. Alder (*Alnus* spp.; 37 per cent) and rose (28 per cent) provided the most understory cover in the Whitemud plot while beaked hazelnut (41 per cent) and red osier dogwood (22 per cent) provided the most in the Mackinnon plot.

4.2.1.8 Dead Tree

No large tracts of this habitat occurred. It is largely located among living stands of balsam poplar and trembling aspen. Because dead trees attract perching birds the habitat was sampled. Composition of the understory was not investigated.

Additional information concerning aspect, slope, and species distribution of the various habitats is outlined in Appendix C.

4.1.3 Inventory of Wildlife Species

4.1.3.1 Bird Species Observed

For the three field seasons pooled, Groat Road Ravine study area had the least species diversity (36 species) and Whitemud Creek Ravine had the greatest species diversity (60 species). For each of winter, spring, and summer field seasons, Groat Ravine study area had the least species diversity and Whitemud Creek Ravine study area the greatest (Table 2).

TABLE 2

BIRD SPECIES OBSERVED IN RAVINE STUDY AREAS IN THREE FIELD SEASONS

Species	Ravine Study Area											
	Mackinnon			Mill Creek			Whitemud Creek			Groat Road		
	Winter	Spring	Summer	Winter	Spring	Summer	Winter	Spring	Summer	Winter	Spring	Summer
Western Grebe		X										
Mallard		X			X		X	X			X	
Red-tailed Hawk							X	X	X			
Merlin	X		X	X	X	X	X	X	X	X		
American Kestrel		X	X					X				X
Ruffed Grouse								X				
Ring-necked Pheasant	X	X	X	X	X	X		X			X	
Gray Partridge							X					
Spotted Sandpiper								X				
California Gull											X	
Ring-billed Gull		X	X		X	X		X	X	X	X	X
Franklin's Gull		X	X		X	X		X	X		X	X
Rock Dove	X	X	X	X		X				X	X	X
Great Horned Owl	X						X	X				
Snowy Owl					X							
Hawk Owl	X											
Ruby-throated Hummingbird			X									
Common Flicker	X	X	X		X	X	X	X	X		X	X
Pileated Woodpecker							X		X			
Yellow-bellied Sapsucker								X				
Hairy Woodpecker	X			X			X		X			
Downy Woodpecker	X			X			X		X			X
Black-backed Three-toed Woodpecker	X						X					

TABLE 2, Continued

Species	Ravine Study Area											
	Mackinnon			Mill Creek			Whitemud Creek			Groat Road		
	Winter	Spring	Summer	Winter	Spring	Summer	Winter	Spring	Summer	Winter	Spring	Summer
Northern Three-toed Woodpecker							X					
Eastern Kingbird								X	X		X	
Say's Phoebe								X	X			
Least Flycatcher		X						X	X		X	X
Olive-sided Flycatcher			X					X	X			
Tree Swallow		X			X							
Purple Martin		X			X	X		X	X		X	X
Blue Jay	X	X	X	X	X	X	X	X	X	X	X	X
Black-billed Magpie	X	X	X	X	X	X	X	X	X	X	X	X
Common Crow	X	X		X	X	X	X	X		X	X	X
Black-capped Chickadee	X	X	X	X	X	X	X	X	X	X	X	X
Boreal Chickadee	X											
White-breasted Nuthatch				X			X					
Red-breasted Nuthatch							X		X			
House Wren		X	X		X	X		X	X		X	
Catbird		X				X		X	X		X	X
Brown Thrasher									X			
American Robin		X	X		X	X	X	X	X	X	X	X
Veery								X				
Ruby-crowned Kinglet		X						X				
Bohemian Waxwing	X			X			X			X		
Cedar Waxwing			X		X	X		X	X		X	X
Starling		X	X	X	X	X	X	X	X	X	X	X
Red-eyed Vireo		X	X		X	X		X	X			X
Warbling Vireo					X							

TABLE 2, Continued

Species	Ravine Study Area											
	MacKinnon			Mill Creek			Whitemud Creek			Groat Road		
	Winter	Spring	Summer	Winter	Spring	Summer	Winter	Spring	Summer	Winter	Spring	Summer
Tennessee Warbler			X			X			X			
Yellow Warbler			X		X			X	X		X	X
House Sparrow		X		X	X	X	X	X			X	X
Western Meadowlark								X	X			
Northern Oriole		X	X		X	X		X	X		X	X
Rusty Blackbird		X			X	X		X	X		X	X
Common Grackle					X						X	
Brown-headed Cowbird									X		X	
Western Tanager								X	X			
Evening Grosbeak	X	X		X	X		X			X	X	
Pine Grosbeak	X			X			X					
Hoary Redpoll	X											
Common Redpoll	X			X			X					
Pine Siskin		X	X		X	X		X	X			X
American Golden Finch						X	X					
Red Crossbill	X	X	X	X	X	X			X			
White-winged Crossbill	X						X					
Savannah Sparrow								X	X			
Dark-eyed Junco		X	X		X	X			X		X	X
Tree Sparrow								X				
Chipping Sparrow		X	X		X	X		X	X		X	X
Clay-coloured Sparrow		X	X		X	X		X	X		X	X
White-crowned Sparrow		X			X						X	
White-throated Sparrow		X			X	X			X			
Song Sparrow					X			X				
TOTAL SPECIES IDENTIFIED	21	33	26	17	32	28	25	40	38	11	30	25
TOTAL SPECIES IDENTIFIED FOR ALL FIELD SEASONS		50			42			60			36	

4.1.3.2 Recreation Potential Provided by Birds

The recreational quality of a ravine may be measured in terms of the total number of birds a person can expect to encounter within all eight habitats, and in each of the individual habitats for each of the seasons.

During winter, a recreational birdwatcher could expect to detect more birds in a single visit to Mill Creek Ravine (135 birds in four hours of one-half hour observational sessions in each of eight habitat types). The observer would see only 22.3 birds in the same time period and habitats within Groat Ravine (Table 3).

In spring, an observer would encounter the most birds in Mill Creek Ravine (57.4 birds in four hours of one-half hour observational sessions in each of eight habitat classifications). He would encounter the least number of birds in Groat Ravine (34.3 birds; Table 4).

In summer, more birds per observational session would be encountered in Whitemud Creek Ravine (65.7 birds). Fewest birds would be encountered in Groat Ravine (43.2 birds; Table 5).

4.1.3.3 Statistical Treatment of Plot-Point Bird Data

4.1.3.3.1 Variables 1-4--all birds including bohemian waxwings. There were significant differences ($p < .05$) between the ravines, seasons, and the interaction of ravines and seasons (Table 6).

TABLE 3

NUMBER OF BIRDS EXPECTED IN ONE VISIT TO RAVINES IN WINTER*

Habitat	Ravine Study Area			
	Mackinnon	Mill Creek	Whitemud Creek	Groat
Grassland	15.3	15.2	1.8	.17
Shrubland	9.0	4.5	2.8	9.3
White Spruce - Poplar	7.0	19.3	17.2	1.3
White Spruce - White Birch	21.8	8.2	3.3	2.0
White Spruce	6.6	23.3	5.7	2.7
Poplar	13.8	3.3	3.2	.83
Poplar - White Birch	7.2	3.0	6.0	1.2
Dead Tree	23.0	58.8	7.0	4.8
Total	103.7	135.6	47.8	22.3
Average	12.96	16.95	5.97	2.78

*Number of birds expected in single visit is tabulated by summing average number of birds observed in each habitat over six replications.

TABLE 4

NUMBER OF BIRDS EXPECTED IN ONE VISIT TO RAVINES IN SPRING*

Habitat	Ravine Study Area			
	Mackinnon	Mill Creek	Whitemud Creek	Groat
Grassland	7.5	7.3	8.3	5.7
Shrubland	3.8	9.7	5.0	2.5
White Spruce - Poplar	10.7	7.7	9.0	4.2
White Spruce - White Birch	7.2	5.3	5.8	3.2
White Spruce	5.5	8.0	1.8	3.2
Poplar	6.2	5.7	3.7	5.2
Poplar - White Birch	8.0	6.2	3.0	9.3
Dead Tree	7.2	7.5	7.5	1.0
Total	56.1	57.4	44.1	34.3
Average	7.01	7.17	5.51	4.28

*Number of birds expected in single visit is tabulated by summing average number of birds observed in each habitat over six replications.

TABLE 5

NUMBER OF BIRDS EXPECTED IN ONE VISIT TO RAVINES IN SUMMER*

Habitat	Ravine Study Area			
	Mackinnon	Mill Creek	Whitemud Creek	Groat
Grassland	11.9	6.3	23.3	.67
Shrubland	3.7	4.7	7.3	4.3
White Spruce - Poplar	6.7	4.7	6.5	3.3
White Spruce - White Birch	11.5	10.5	3.3	6.2
White Spruce	4.8	8.7	17.0	8.5
Poplar	5.0	5.8	3.0	5.2
Poplar - White Birch	2.7	5.7	1.8	12.2
Dead Tree	5.2	10.3	3.5	2.8
Total	51.5	56.7	65.8	43.2
Average	6.43	7.08	8.2	5.4

*Number of birds expected in single visit is tabulated by summing average number of birds observed in each habitat over six replications.

4.1.3.3.2 Variable 5--sum of all birds excluding bohemian waxwings. Bohemian waxwings are characteristically a flocking bird in winter. Because of this behavioural trait, when one bird is detected, it is usually accompanied by many others. Recording large flocks of birds can provide misrepresentative data even though they result from normal sampling procedures. For this reason, waxwings were excluded from the statistical treatment of "all birds" in order to determine if the waxwings represented a significant factor in the difference in bird populations between ravine study areas. Although such species as evening grosbeaks (*Hesperiphona vespertina*), red crossbills (*Loxia curvirostra*) and white-winged crossbills (*Loxia leucoptera*) also occur in flocks, these flock sizes were not considered sufficient to affect the data to the extent that bohemian waxwings would.

When bohemian waxwings were excluded from "total birds" there were significant differences ($p < .05$) between the ravine study areas, the habitats within the ravine study areas ($p < .05$), the interaction of ravines and habitats ($p < .05$), ravines and seasons ($p < .05$), and habitats and seasons ($p < .05$; Table 7).

4.1.3.3.3 Variables 6-9--jays, magpies and crows. Data for jays, magpies and crows, when subjected to the same statistical treatment, showed significant differences between ravine study areas ($p < .05$), habitats within ravine study areas ($p < .05$), seasons ($p < .05$), and the interaction

TABLE 6

BMDO2V ANALYSIS OF VARIANCE FOR
FACTORIAL DESIGN FOR ALL BIRDS

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares	F
1	3	17595.78971	5865.26172	4.59*
2	7	16801.86103	2400.26562	1.88
3	2	8899.45239	4449.72266	3.48*
12	21	40496.76913	1928.41748	1.51
13	6	19648.34642	3274.72437	2.56*
23	14	26229.84668	1873.56030	1.47
Residual	42	53705.25000	1278.69629	
Total	95	183377.18750		

*Denotes statistically significant difference.

TABLE 7

BMDO2V ANALYSIS OF VARIANCE FOR FACTORIAL
DESIGN FOR ALL BIRDS EXCLUDING WAXWINGS

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares	F
1	3	30146.58594	30146.58594	3.32*
2	7	73534.31901	10504.90234	7.81*
3	2	639936.81250	319968.37500	1.30
12	21	74206.98568	3533.66577	117.55*
13	6	127576.69531	21262.78125	3.86*
23	14	126496.99219	9035.49609	11.08*
Residual	42	114322.00000	2721.97607	
Total	95	1246514.00000		

*Denotes statistically significant difference.

between ravines and habitats ($p < .05$; Table 8).

4.1.3.3.4 Variables 10-13--passerines. When passerines were analyzed by using the same statistical method, the difference between ravine study areas was significant ($p < .05$), and also the interaction between ravines and seasons ($p < .05$; Table 9).

Some of the data concerning bird groups were better suited to a two-way BMDO2V analysis of variance (Dixon 1968). Variables 14, 15, and 16 were subjected to that statistical treatment although this treatment is not so sensitive as the three-way analysis of variance.

4.1.3.3.5 Variable 14--sum of all finches in all field seasons. When the sum of all finches in all field seasons was treated with a two-way analysis of variance, there was a significant difference in the number of finches for the four ravine study areas ($p < .05$; Table 10).

4.1.3.3.6 Variable 15--the sum of all black-capped chickadees. When the number of black-capped chickadees in the four ravine study areas was treated using two-way analysis of variance, there was a significant difference between both ravines and habitats ($p < .05$) for the sum of all black-capped chickadees (Table 11).

4.1.3.3.7 Variable 16--bohemian waxwings in winter and spring field seasons. There was a significant difference ($p < .05$) between the numbers of bohemian waxwings in the ravine study areas (Table 12).

TABLE 8

BMDO2V ANALYSIS OF VARIANCE FOR
FACTORIAL DESIGN FOR JAYS, MAGPIES AND CROWS

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares	F
1	3	545.78950	181.92982	15.71*
2	7	455.45685	65.06526	5.62*
3	2	99.39496	49.65748	4.30
12	21	602.37734	28.68463	2.48*
13	6	135.02276	22.50378	1.94
23	14	142.60588	10.18613	0.88
Residual	42	486.30371	11.57866	
Total	95	2466.95020		

*Denotes statistically significant difference.

TABLE 9

BMDO2V ANALYSIS OF VARIANCE FOR
FACTORIAL DESIGN FOR PASSERINES

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares	F
1	3	22830.98714	7610.32813	5.51*
2	7	17805.58429	2543.65479	1.84
3	2	20072.14453	10036.07031	1.27
12	21	36666.47814	1746.02271	1.27
13	6	26997.84885	4332.97266	3.14*
23	14	26361.45773	1882.96118	1.36
Residual	42	57947.93750	1379.71265	
Total	95	207682.37500		

*Denotes statistically significant difference.

TABLE 10

BMDO2V ANALYSIS OF VARIANCE FOR
FACTORIAL DESIGN FOR FINCHES

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares	F
1	3	5261.00000	1753.66650	3.42*
2	7	5581.50000	797.35693	1.55
Residual	21	10783.50000	513.50000	
Total	31	21626.00000		

*Denotes statistically significant difference.

TABLE 11

BMDO2V ANALYSIS OF VARIANCE FOR
FACTORIAL DESIGN FOR BLACK-CAPPED CHICKADEES

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares	F
1	3	304.37500	101.45833	3.64*
2	7	962.37500	137.48213	4.93*
Residual	21	586.12500	27.91071	
Total	31	1852.87500		

*Denotes statistically significant difference.

TABLE 12

BMDO2V ANALYSIS OF VARIANCE FOR FACTORIAL DESIGN FOR BOHEMIAN WAXWINGS IN WINTER AND SPRING

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares	F
1	3	36605.12500	12201.70700	3.66*
2	7	30608.37500	4372.62500	1.31
Residual	21	70036.25000	3335.05933	
Total	31	137249.75000		

*Denotes statistically significant difference.

TABLE 13

NUMBER OF COCK PHEASANTS DETERMINED IN RAVINE STUDY AREAS BY CONDUCT OF SPRING CROWING COUNT

	Ravine Study Area			
Survey	Mackinnon	Mill Creek	Whitemud Creek	Groat Road
First	0	9	0	1
Second	0	12	0	0
Average	0	10.5	0	0.5

4.1.3.4 Inventory of Gallinaceous Birds

4.1.3.4.1 Ring-necked pheasant. Substantial numbers of ring-necked pheasants were located only in Mill Creek Ravine (Table 13). Of note is the cock-hen ratio in this area (Table 14). Based on a combination of crowing counts and flushing results, and assuming that all birds were heard and there were no duplicates in the crowing counts, it appears that in 1973 there was a pre-breeding population of 22 birds composed of 11 cocks and 11 hens.

4.1.3.4.2 Ruffed grouse. Table 15 presents the results of the ruffed grouse drumming survey conducted in early May 1973. It is evident that the ravine study areas held low grouse populations.

During the habitat mapping of the Whitemud Creek Ravine study area in July 1972, one brood of grouse consisting of an adult and approximately seven chicks was encountered. Some grouse tracks were observed in the white spruce-balsam poplar bottomlands during the winter season and a flush of one single bird was made during the spring field season in the same vicinity.

No ruffed grouse or evidence of this species was detected in Mackinnon, Mill Creek or Groat Ravine study areas.

4.1.3.5 Mammal Observations

Mammal inventories for environmental impact assessments, park interpretive programs, and other purposes are

TABLE 14

COCK PHEASANT - HEN PHEASANT RATIO BASED ON WINTER FLUSHES IN RAVINE STUDY AREAS

Flush Date	Ravine Study Area	
	Mackinnon	Mill Creek
11 January 1973		1:0
15 January 1973	0:1	
2 February 1973		1:1
2 February 1973		1:0
3 February 1973		0:1
8 March 1973		1:0
22 March 1973	1:0	
23 March 1973		1:0
31 March 1973		1:0
2 April 1973		1:4
Average	0.5:0.5	0.8:0.8

TABLE 15

NUMBER OF RUFFED GROUSE DRUMMING MALES IN RAVINE STUDY AREAS

Survey	Ravine Study Area			
	Mackinnon	Mill Creek	Whitemud Creek	Groat Road
First	0	0	1	0
Second	0	0	2	0
Average	0	0	1.5	0

generally conducted over larger areas than the ravine study sites. As with some bird species, the home ranges of many mammals are larger than the home range provided by a ravine study area. It is therefore difficult to approximate densities for many of the mammals detected during the field investigations. For this reason, approximations of densities for some of the mammals detected are not given. Reference is made only to their presence in a given ravine.

Table 16 indicates mammals located in the study ravines during field investigations. Records made by persons other than the author are not included.

4.1.3.5.1 Little brown bat (Myotis lucifugus). Although this mammal probably occupies all of the ravine study areas, it was observed only in Mackinnon Ravine (Figure 7). Little brown bats may occupy buildings surrounding the ravines and use the ravine areas for feeding on insects. No attempt was made at fixing the densities of little brown bats for any of the ravines.

4.1.3.5.2 Mink (Mustela vison). Tracks of one mink were observed in Mackinnon Ravine (Figure 7).[4] The tracks came from a north-facing slope white spruce forest and stopped by some chicken bones thrown from the 142nd Street

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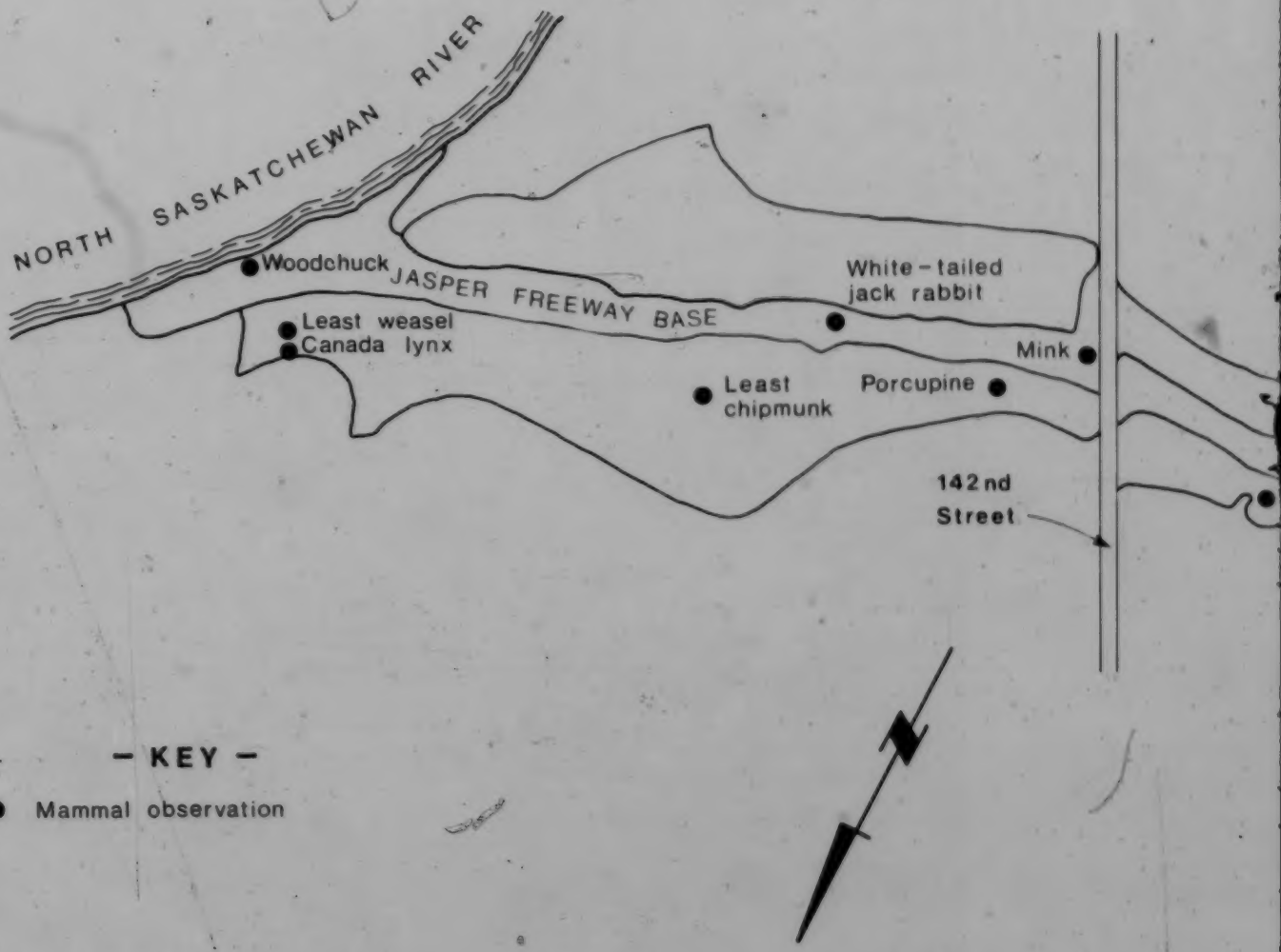
[4]Figures 7 to 10 show ravine study areas and locations of evidence of mammals.

TABLE 16

LIST OF MAMMALS DETECTED IN RAVINE STUDY AREAS

Species	Ravine Study Area			
	Mackinnon	Mill Creek	Whitemud Creek	Groat Road
Little brown bat	X			
Mink	X			
Least weasel	X			
Striped skunk	X	X	X	
Coyote			X	
Canada lynx	X	X	X	
Woodchuck	X			X
Richardson ground squirrel			X	
Least chipmunk	X		X	
Red squirrel	X	X	X	X
Beaver	X		X	
Muskrat			X	
Porcupine	X		X	X
White-tailed jackrabbit	X			
Snowshoe hare	X	X	X	
White-tail deer		X	X	
Moose			X	



– KEY –

● Mammal observation

SCALE 1:6000

0 60 120 180 240 300 Metres

104

COLOUR

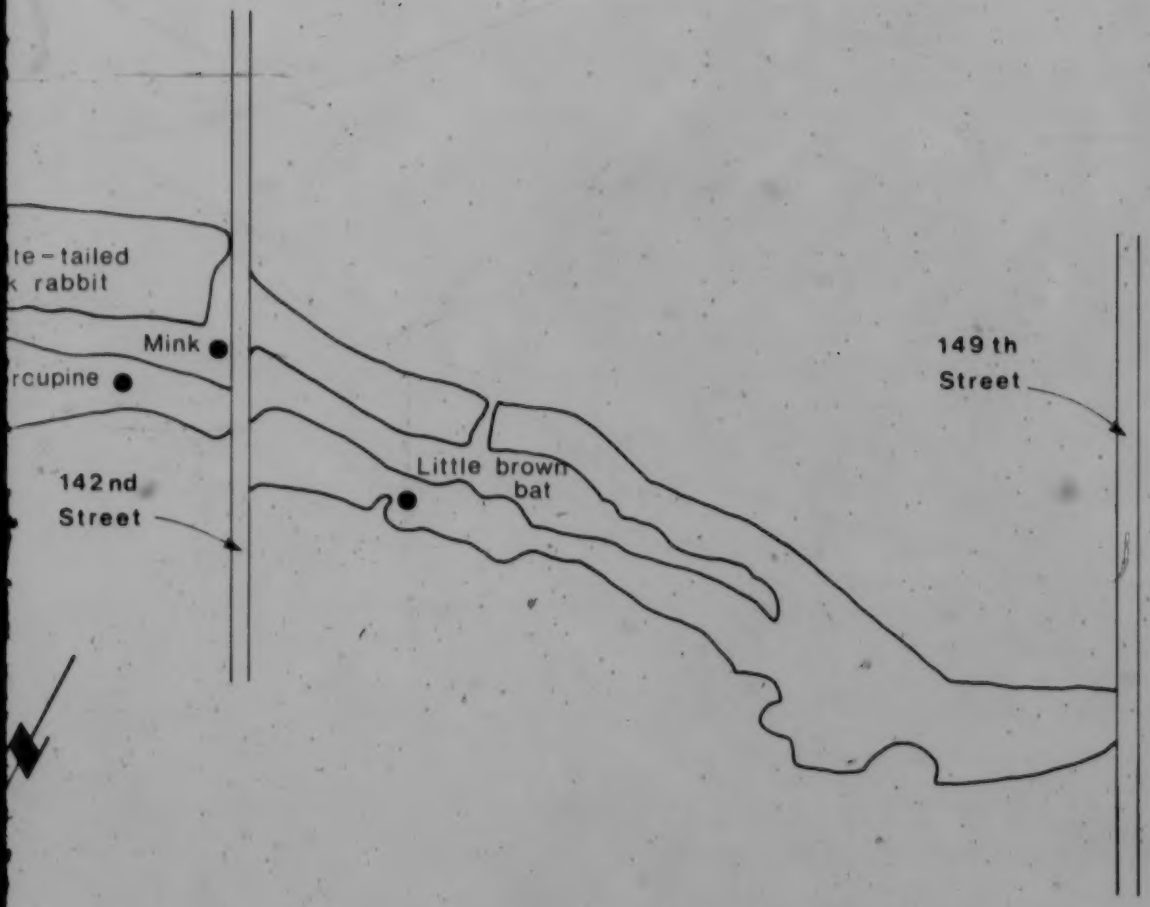
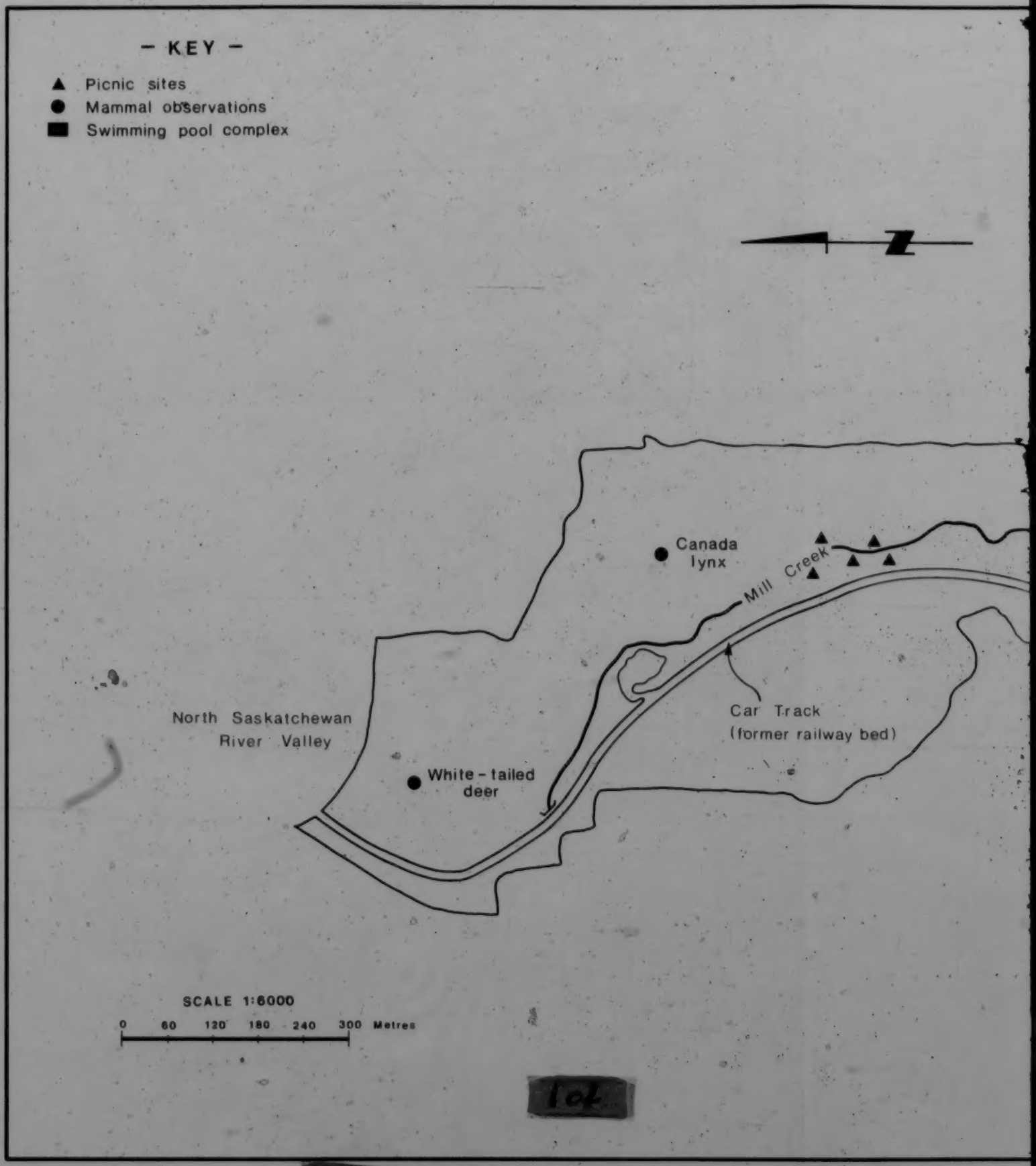


FIGURE 7
MACKINNON RAVINE
Locations of mammals or of their evidence

242

COLOUR


- KEY -
Picnic sites
Mammal observations
Swimming pool complex
N
Canada lynx
Mill Creek
North Saskatchewan River Valley
White - tailed deer
Car Track (former railway bed)
SCALE 1:6000
0 60 120 180 240 300 Metres
104
COLOUR

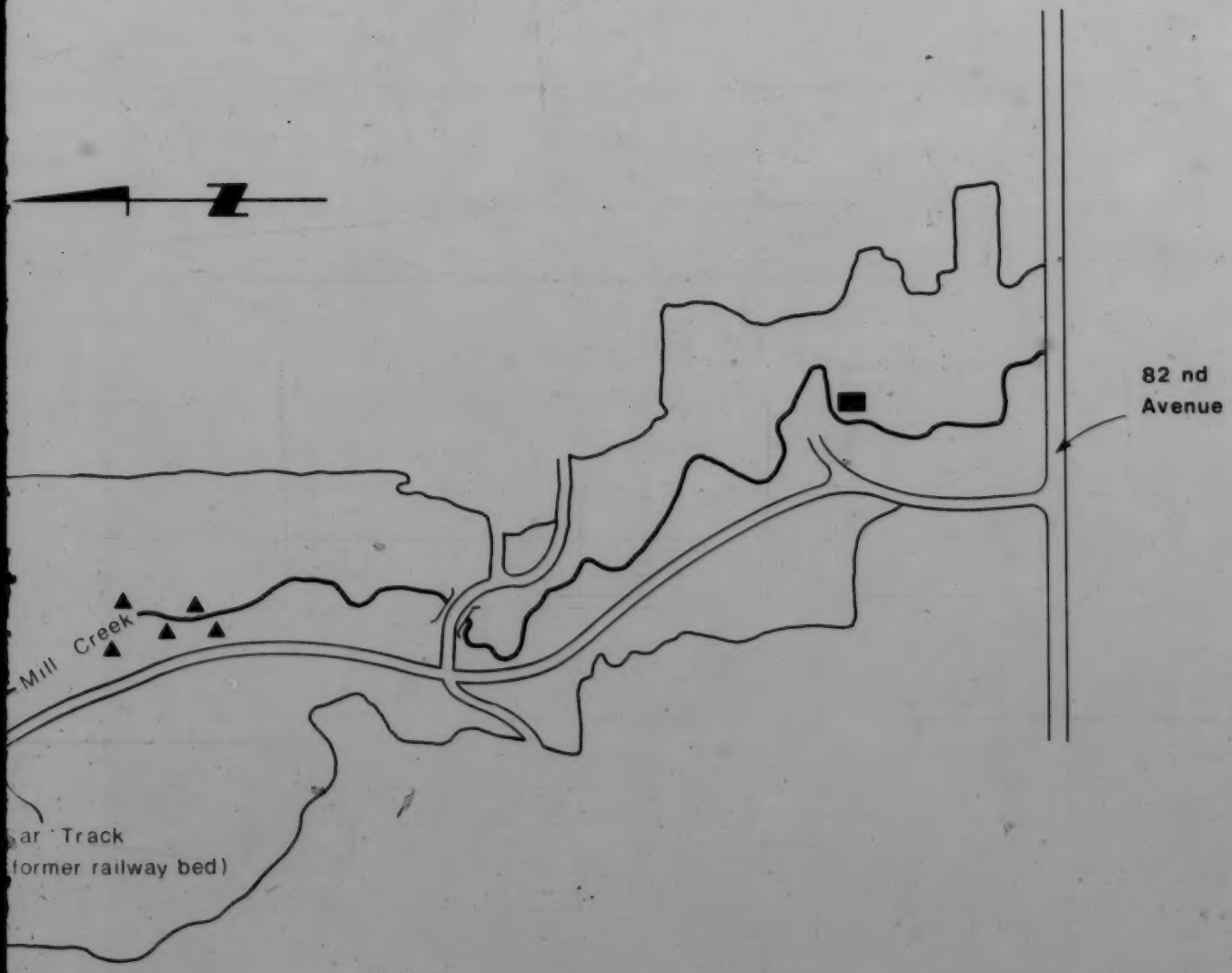
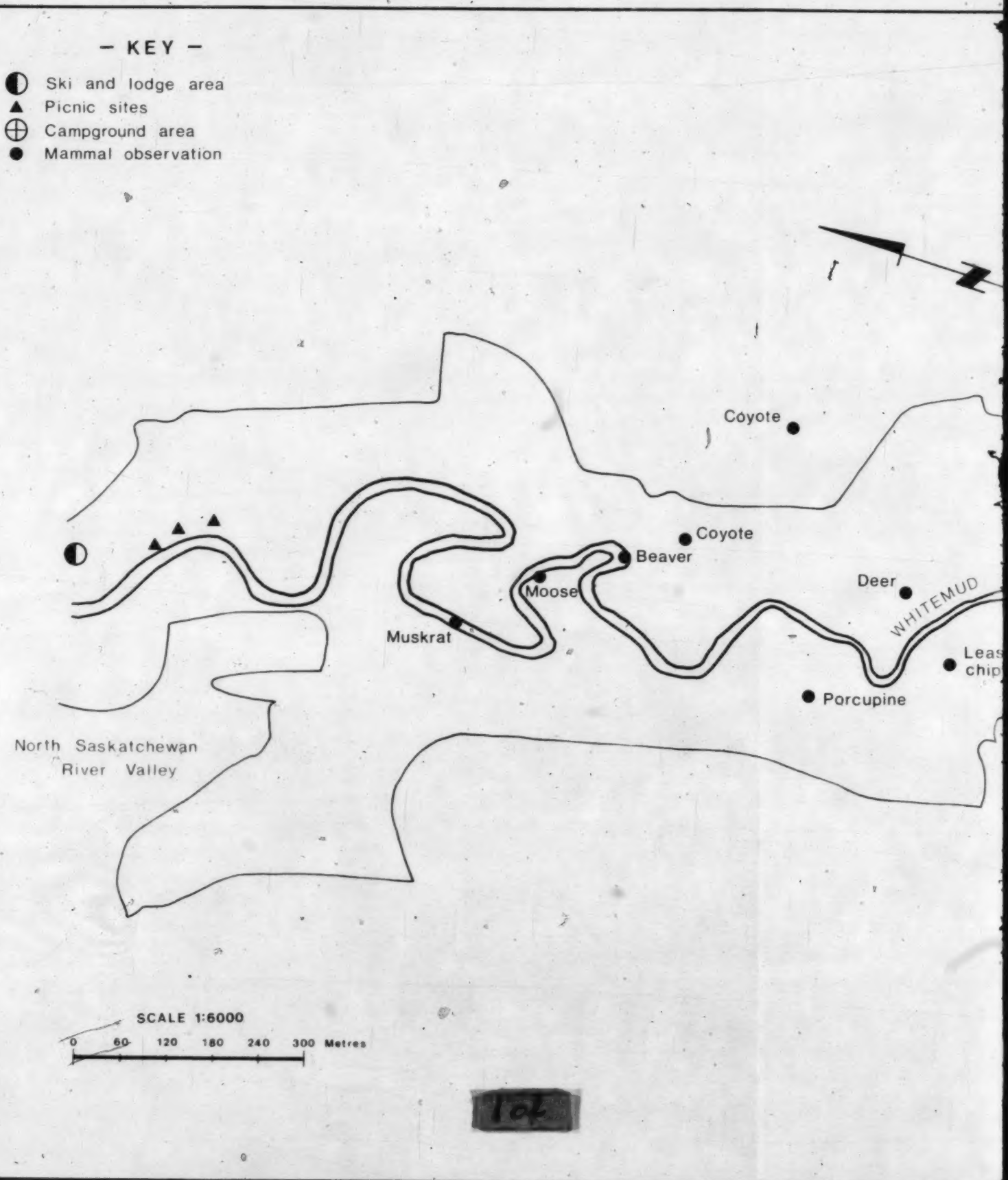


FIGURE 8
MILL CREEK RAVINE

Locations of mammals or of their evidence and locations of recreation facilities

242

COLOUR


– KEY –
Ski and lodge area
Picnic sites
Campground area
Mammal observation
Coyote
Coyote
Beaver
Moose
Deer
WHITEMUD
Muskrat
Porcupine
North Saskatchewan
River Valley
SCALE 1:6000
0 60 120 180 240 300 Metres

104

COLOUR

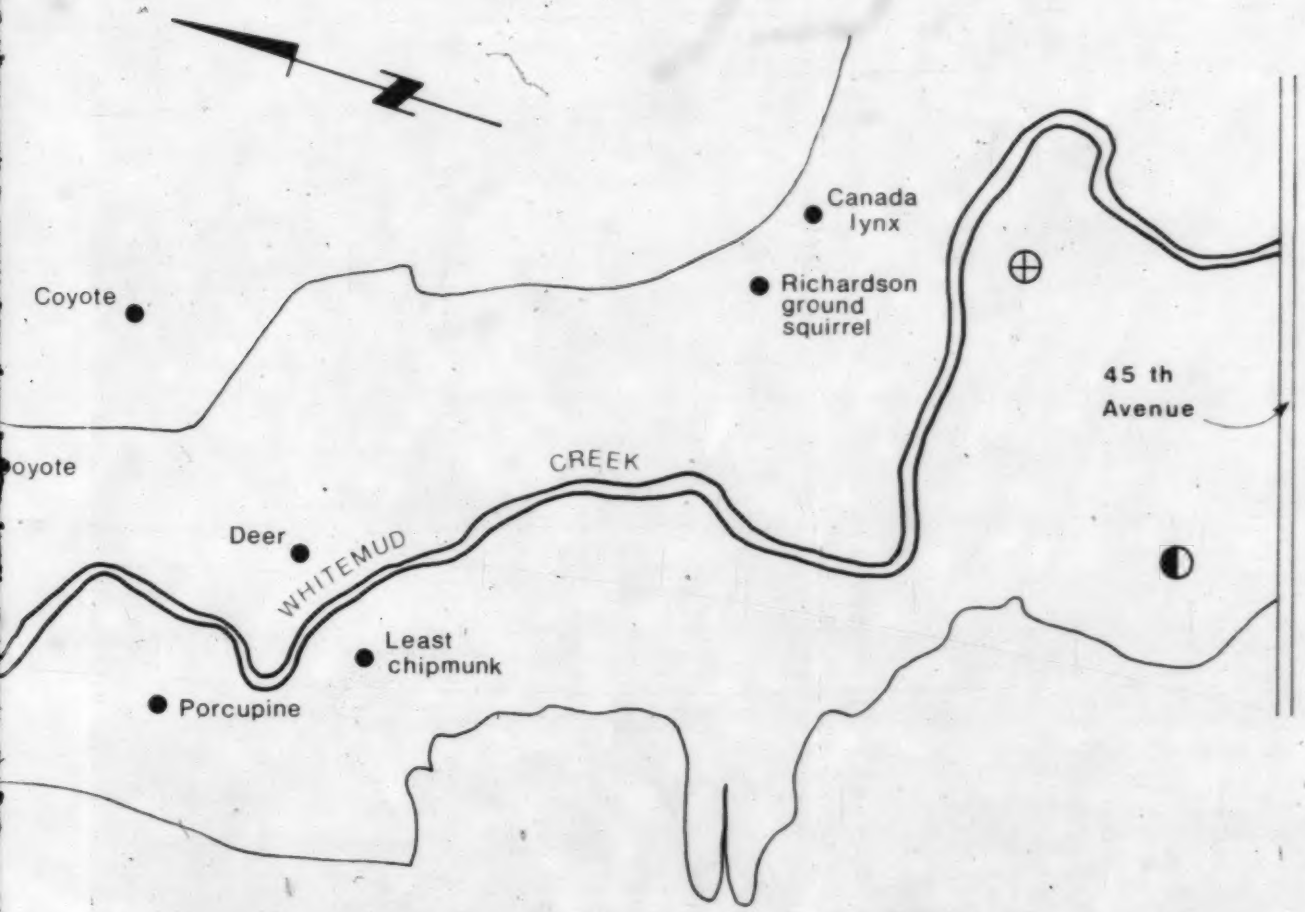
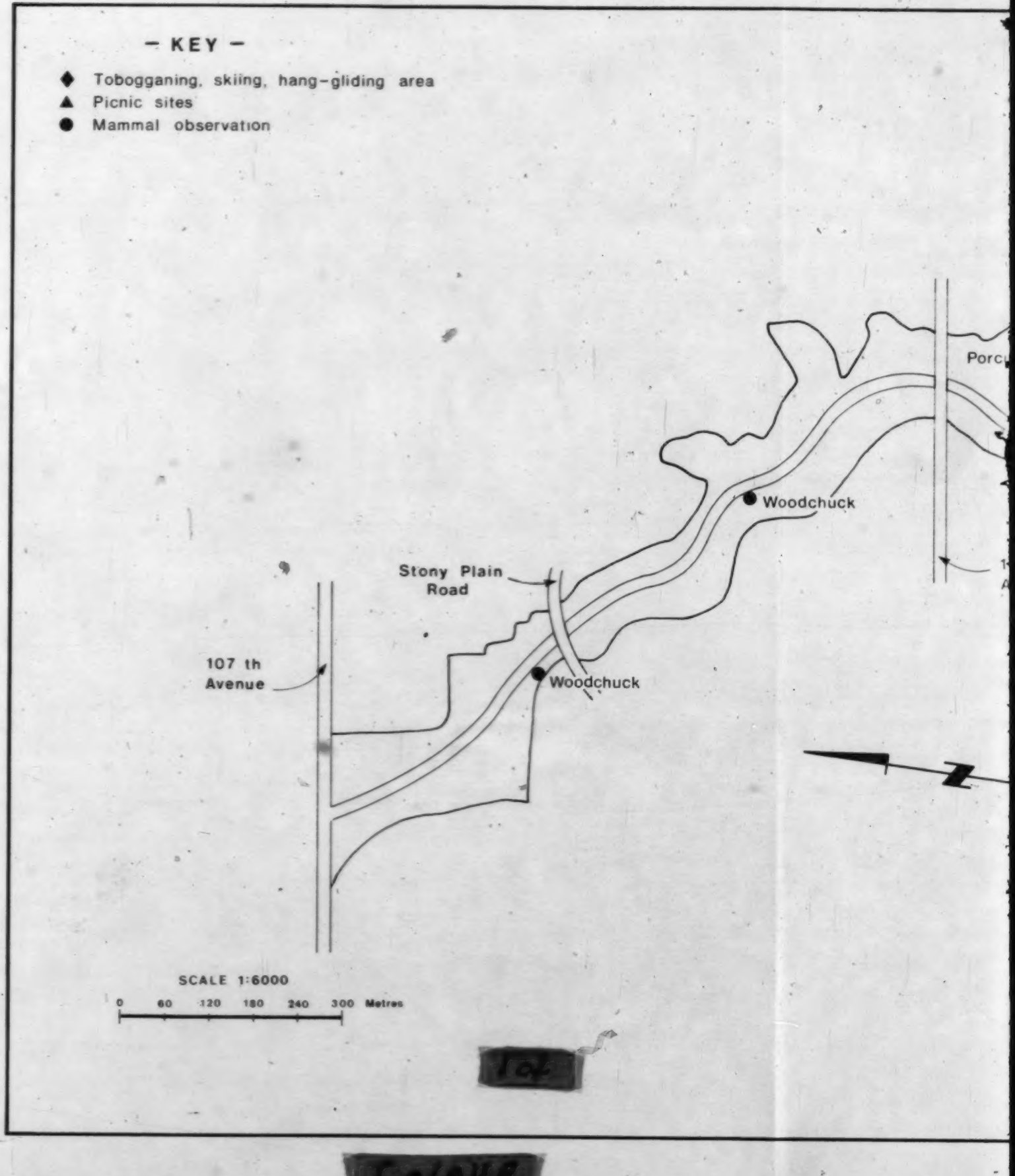


FIGURE 9
WHITEMUD CREEK RAVINE

Locations of mammals or of their evidence and locations of recreation facilities

2 of 2

COLOUR


– KEY –
Tobogganing, skiing, hang-gliding area
Picnic sites
Mammal observation
Porc
Woodchuck
Stony Plain Road
107 th Avenue
Woodchuck
SCALE 1:6000
0 60 120 180 240 300 Metres
104
COLOUR

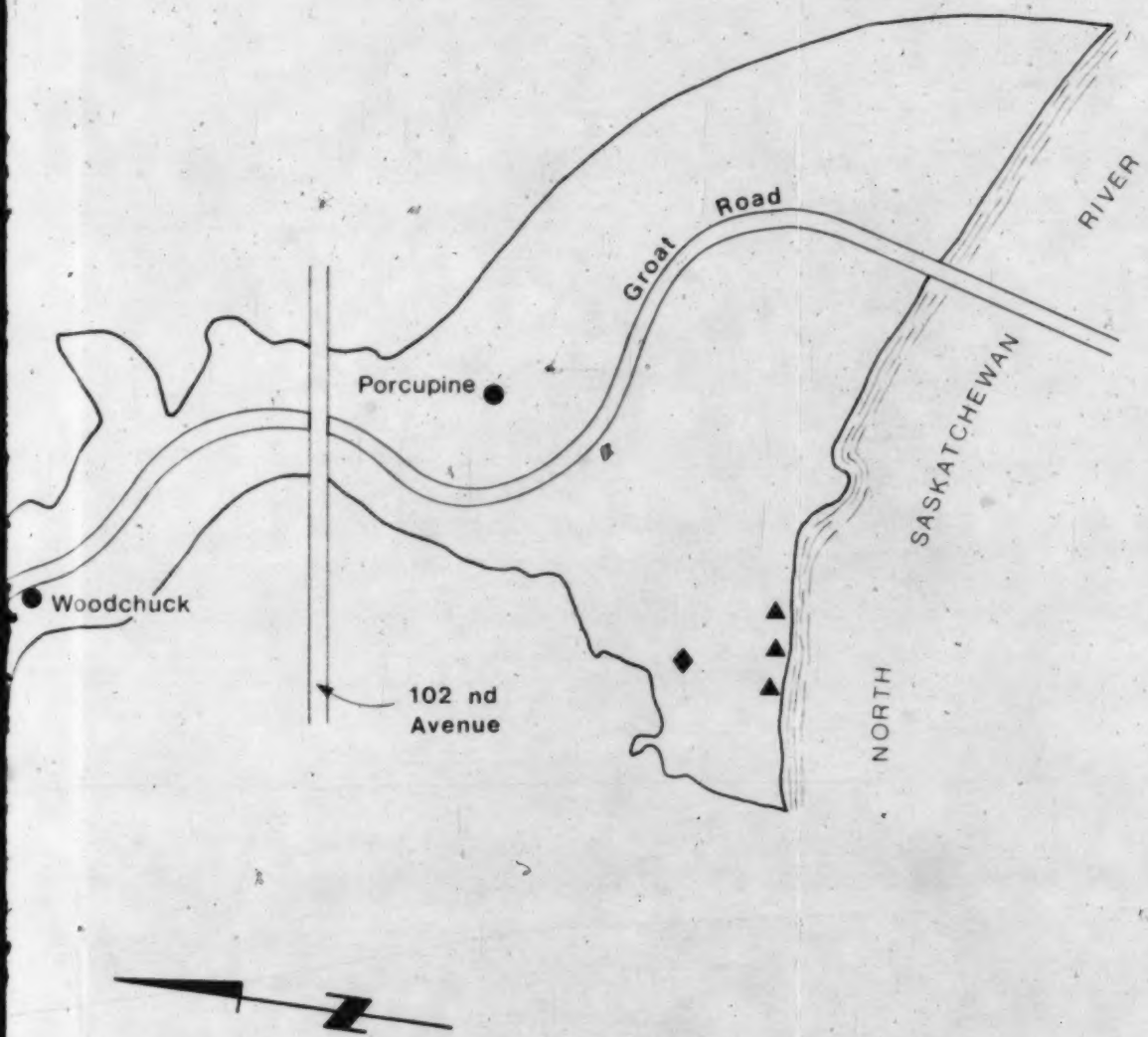


FIGURE 10
GROAT RAVINE

Locations of mammals or of their evidence and locations of recreation facilities

242

COLOUR

bridge crossing the Mackinnon Ravine. Tracks indicated that the animal fed and then retreated back to the valley sides. A preferred habitat of the mink is stream banks, similar to those found along Whitemud Creek, and although no evidence of this mammal was discovered there, they probably occupy the valley from time to time. Limiting factors, however, may be the absence of a reliable source of food and human presence.

4.1.3.5.3 Least weasel (Mustela nivalis). Tracks of one least weasel were observed in Mackinnon Ravine on a south-facing, grassland plot (Figure 7) during winter field investigations. There was evidence that the weasel had been actively pursuing small mammals in this habitat type.

Insufficient evidence of this mammal's occurrence was detected to establish densities for the ravines.

4.1.3.5.4 Striped skunk (Mephitis mephitis). Striped skunks appear to be adapted to an urban environment. They, and evidence of their occurrence, were detected in all ravine study areas with the exception of Groat Road Ravine. Their tracks were first observed in the ravines in early March. In the Mackinnon Ravine area the animals frequented garbage cans of homes built next to the ravine. The animals have been known to den under doorsteps of homes in Mackinnon Ravine. In winter, they denned in an abandoned sewer shed located along a valley side. No attempt was made to establish the density of the animals in each of the ravine study

areas. Populations of one skunk to 4 ha (Burt 1964) are considered to be high, but this density is probably not reached in the ravine study areas.

4.1.3.5.5 Coyote (Canis latrans). Coyotes were detected only in the Whitemud Creek Ravine study area. Their tracks were visible in both the mixed forest bottomland and the white spruce forests of the east side of the valley. In winter, these animals are frequently observed mousing in hayfields on the eastern border of the valley. Although no dens were discovered in the ravine study area, provincial pest control specialists from the Department of Agriculture discovered a den in an old granary on the University farm during winter 1974. The coyotes frequenting the Whitemud Creek Ravine study area may have originated from this den. In California, Gill (1965) reports coyotes living under buildings along a proposed freeway route prior to its construction.

In addition to rodents in the hayfields, snowshoe hares are present in the ravine study area and may provide coyotes with a prey species, although no evidence of kills was discovered.

4.1.3.5.6 Canada lynx (Lynx canadensis). Lynx were detected in all of the study ravines except Groat Road Ravine. In the winter of 1973, evidence of lynx were found on a south-facing slope of Mackinnon Ravine. Track patterns and the presence of scats containing undigested

remains of small mammals indicated the lynx had been mousing on this open hillside. Lynx scats from Whitemud Creek Ravine were analyzed and found to contain both hair from snowshoe hare and other small mammals. Predators are thought to follow linear hunting territories (Dorney, pers. comm.) and it is possible that the study ravines provide such territories. Lynx may move into the city in winter in search of food by following the main river valley. They may then follow the tributary ravines.

The lynx's ability to adapt to urban conditions may vary from one individual to the next and availability of food elsewhere. In years when food is readily available outside the city, the animals travel less and their chances of wandering into the city is less. No evidence of lynx breeding in the city was discovered.

Indications of the animals' tolerance of urban conditions were, the author's observation of (1) a lynx mousing in a flower bed outside a golf club restaurant window in the river valley, and (2) a lynx walking through a crowd of winter recreationists in the river valley at Mayfair Civic Park.

4.1.3.5.7 Woodchuck (Marmota monax). These mammals are difficult to detect and were observed only in the Groat Road Ravine and Mackinnon Ravine study areas. In the former ravine, two dens were discovered during the spring and summer field investigations. One was situated in the valley

bottom at the lower edge of a shrubland plot, about 8 m from Groat Road. The other was in an old woodpile situated within poplar habitat (Figure 10).

In Mackinnon Ravine, a den was found at the confluence of the ravine and the river where large cement blocks and fill have been used to construct a riverside roadbed (Figure 7).

4.1.3.5.8 Richardson ground squirrel (Spermophilus richardsonii). Richardson ground squirrels were detected only in Whitemud Creek Ravine where their hillside burrows are located in shrubland habitat and in adjoining manicured park boulevards (Figure 9).

City ravines do not appear to be as favoured by ground squirrels for habitat as artificially landscaped hillsides or flats surrounding ravines.

4.1.3.5.9 Least chipmunk (Eutamias minimus). Least chipmunks were detected only in Whitemud and Mackinnon Ravines. In both ravines they live within mixed forests more mature than those surrounding (Figs.7 & 9). Although habitat favourable to least chipmunks is available in Mill Creek and Groat Road Ravines, none were detected. No explanation can be offered other than in the case of Groat Road Ravine, where habitat may be too small and linear in nature. Another cause may be predation of wandering housecats.

4.1.3.5.10 Red squirrel (Tamiasciurus hudsonicus). Red squirrels occur in all four of the ravine study areas.

In almost all instances they were observed in mixed wood forest in or near stands of white spruce. Because all four ravines have good squirrel habitat, squirrels are relatively abundant. Although the habitat is not extensive within Groat Road Ravine, there is an extension of squirrel habitat from the ravine into the surrounding residential areas. These are older areas and many yards have mature spruce trees that provide habitat for squirrels in addition to that available in the ravine. In general, red squirrels seem well adapted to the urban environment as evidenced by their numbers (Flyger 1974) and by the fact that they often feed at urban bird feeders.

Tables 17 to 19 show the maximum number of squirrels encountered in any single visit to each of the plots for the three field seasons. Because each of the sample plots was approximately .26 ha in size, some comparisons may be made, through extrapolation, with red squirrel densities shown in the literature. MacClintock (1970) states that in favourable habitats there is one squirrel for approximately every ha. Klugh (1927) found the home range of male red squirrels in New Brunswick spruce woods to be approximately 230 m^2, and in areas of abundance, observed two squirrels to approximately 914 m^2. Kilham (1954) observed the home range to be 85 m by 37 m in white pine habitat. Burt (1964) indicates that a density of two squirrels to 1.2 ha in prime habitat is average.

TABLE 17

MAXIMUM NUMBER OF SQUIRRELS AND HECTARES PER SQUIRREL IN HABITAT PLOTS IN WINTER IN THE RAVINE STUDY AREAS

	Ravine Study Area							
	Mackinnon		Mill Creek		Whitemud Creek		Groat Road	
Habitat Type	Number	Hectares	Number	Hectares	Number	Hectares	Number	Hectares
White Spruce-Poplar	1	.26	2	.26	2	.26	-	-
White Spruce-White Birch	2	.13	-	-	1	.13	-	-
White Spruce	2	.13	1	.13	-	-	-	-

TABLE 18

MAXIMUM NUMBER OF SQUIRRELS AND HECTARES PER SQUIRREL IN HABITAT PLOTS IN SPRING IN THE RAVINE STUDY AREAS

Habitat Type	Ravine Study Area							
	Mackinnon		Mill Creek		Whitemud Creek		Groat Road	
	Number	Hectares	Number	Hectares	Number	Hectares	Number	Hectares
White Spruce-Poplar	1	.26	1	.26	1	.26	-	-
White Spruce-White Birch	2	.13	-	-	2	.13	-	-
White Spruce	2	.13	1	.13	-	-	-	-

TABLE 19

MAXIMUM NUMBER OF SQUIRRELS AND HECTARES PER SQUIRREL IN HABITAT PLOTS IN SUMMER IN THE RAVINE STUDY AREAS

Habitat Type	Ravine Study Area							
	Mackinnon		Mill Creek		Whitemud Creek		Groat Road	
	Number	Hectares	Number	Hectares	Number	Hectares	Number	Hectares
White Spruce-Poplar	1	.26	1	.26	1	.26	-	-
White Spruce-White Birch	1	.26	-	-	2	.13	-	-
White Spruce	1	.26	1	.26	-	-	-	-

Based on these comparisons, it is concluded that red squirrel densities in adequate habitat in the ravine study areas are equal to densities found within natural habitat.

4.1.3.5.11 Beaver (Castor canadensis). One of the difficulties in estimating beaver populations near large rivers is accounting for beavers that live in bank burrows rather than building lodges. The common method of establishing populations is by discovering active lodges as evidenced by feed caches and estimating the number of beavers using the lodge based on its size (Hay 1958).

One such active lodge was located within the Whitemud Creek Ravine study area (Figure 9). No more than two beavers were observed simultaneously at this lodge although there may have been more. There are more beavers inhabiting Whitemud Creek Valley upstream from the study area. Based on the number of lodges, it is estimated that one beaver for every 2 km of stream occupy Whitemud Creek Valley. As is common throughout their range, beavers in the study area utilize willows from stream flood plains and trembling aspen along the banks for food and lodge construction.

Beavers were also observed in the North Saskatchewan River at its confluence with Mackinnon Ravine. Beavers here had burrowed in river banks constructed from concrete fill used for the riverside freeway base.

Beavers within the City of Edmonton can be a problem as they have a tendency to construct dams across storm sewer

outlets that empty into the river. It is therefore sometimes necessary for civic agencies responsible for pest control to remove problem animals from the river valley. Beavers also destroy trees in upper Mill Creek Ravine by cutting and felling them.

4.1.3.5.12 Muskrat (Ondatra zibethicus). One muskrat was observed in Whitemud Creek Valley (Figure 9). It was probably a bank dweller. The traditional means of censusing these animals is counting push-ups (Dozier 1948), but this cannot be done with bank dwelling muskrats.

4.1.3.5.13 Porcupine (Erithizon dorsatum). Evidence of porcupines occurs in all of the ravine study areas but Mill Creek Ravine.

In Whitemud Creek Ravine they did considerable damage to birch trees in one location (Figure 9) while in Mackinnon and Groat Road Ravines there was little evidence of feeding and the animals present were likely transients. Costello (1966) claims that the winter feeding range of a porcupine is 5.2 ha and Shapiro (1949) claims a similar feeding range of approximately 5.3 ha. Shapiro also found that porcupine densities ranged from one per 4.4 ha in selected areas to one for .26 ha in other areas. All of these figures are probably greater than the density in Whitemud Creek Ravine.

4.1.3.5.14 Whitetail jackrabbit (Lepus townsendi). Whitetail jackrabbits were observed on one occasion only.

Two apparent transients were encountered on the freeway base of Mackinnon Ravine in the winter field season (Figure 7).

4.1.3.5.15 Snowshoe hare (Lepus americanus). The home range of the snowshoe hare is approximately 4 ha (Burt 1964). Therefore all of the ravine study areas are of sufficient size to support snowshoe hare populations.

The only study area that snowshoe hares were absent from was Groat Road Ravine. Sufficient numbers were encountered in the ravine study areas to warrant a determination of their densities within the habitats they utilized.

Tables 20, 21, and 22 indicate the results of the pellet group survey.

Accounting for all five habitats sampled, the Whitemud Creek Ravine study area was most utilized by snowshoe hares, followed by Mackinnon and Mill Creek Ravines (Tables 20, 21, 22).

No one habitat type was consistently used more than the others (Tables 20, 21, 22). This is perhaps a result of differences in understory composition of habitats of the same classification (Appendix C).

Although from the tables it appears that poplar habitat in Mill Creek Ravine remained unused by hares, this inference likely results from sampling in only one poplar habitat. Evidence of snowshoe hares was encountered within poplar habitat dominated by immature trembling aspen on the east side of the Mill Creek Ravine study area.

TABLE 20

RESULTS OF SNOWSHOE HARE PELLET SURVEY
FOLLOWING WINTER, 1972-1973 IN MACKINNON RAVINE

Habitat Type	Average Number of Pellets per sq. m.*	Number of Pellets in Habitat Plot*	Hare Days Use of Habitat Plot	Hares/ Hectare
White Spruce-Poplar	12.9	38,700	96.8	.25
White Spruce-White Birch	13.00	39,000	97.5	.25
White Spruce	3.2	9,600	24.0	.06
Poplar	28.7	86,220	215.6	.55
Poplar-White Birch	10.5	31,500	78.8	.20
Average	13.7	41,004.0	102.5	.26

*Extrapolated.

TABLE 21

RESULTS OF SNOWSHOE HARE PELLET SURVEY
FOLLOWING WINTER, 1972-1973 IN MILL CREEK RAVINE

Habitat Type	Average Number of Pellets per sq. m.*	Number of Pellets in Habitat Plot*	Hare Days Use of Habitat Plot	Hares/ Hectare
White Spruce-Poplar	4.7	14,160.0	35.4	.09
White Spruce-White Birch	0.0	0.0	0.0	0
White Spruce	0.0	0.0	0.0	0
Poplar	0.0	0.0	0.0	0
Poplar-White Birch	0.0	0.0	0.0	0
Average	0.9	4,164.5	7.1	.02

*Extrapolated.

TABLE 22

RESULTS OF SNOWSHOE HARE PELLET SURVEY
FOLLOWING WINTER 1972-1973 IN WHITEMUD CREEK RAVINE

Habitat Type	Average Number of Pellets per sq. m.*	Number of Pellets in Habitat Plot*	Hare Days Use of Habitat Plot	Hares/ Hectare
White Spruce-Poplar	9.1	27,180	67.9	0.2
White Spruce-White Birch	0.0	0.0	0.0	0.0
White Spruce	8.3	24,900	62.3	0.2
Poplar	15.7	47,100	117.8	0.3
Poplar-White Birch	52.2	156,600	391.5	1.0
Average	17.1	51,156	127.9	0.3

*Extrapolated.

In the white birch-poplar habitat of Whitemud Creek Ravine, the sampling frame included an extremely large pellet group adjacent to a felled trembling aspen which had been browsed extensively by hares. This sample raised the average number of pellets per sample for that habitat.

It is assumed that all undecomposed pellets that lay on the surface of the previous autumn's leaf fall resulted from winter utilization of the area. The length of the time between when the leaves fell and the pellet group sample was taken was approximately 155 days. Using the figure of 400 pellets produced by one cottontail rabbit (*Sylvilagus floridanus*) per day (Cochrane and Staines 1961), for a hare to have used 0.04 ha of habitat for 155 days, the hare would need to produce 62,000 pellets. Using these figures, the computed number of snowshoe hares per hectare of sampled habitats is indicated in Tables 20, 21, and 22.

Care should be exercised in interpretation of the above density figures however. The animal's home range is some 4 ha in size and it is easy for an animal to inhabit one area for denning purposes, and move to another area to feed and defecate. A more reliable measure of utilization is that of "hare days use" (Tables 20, 21, 22).

Whitemud Creek Ravine is more utilized by snowshoe hares than the other ravine study areas for the following possible reasons. This ravine is wider than the others and provides larger tracts of suitably varied habitat for

snowshoe hares. In Mill Creek Ravine, by contrast, browse in the bottomland has been removed to provide picnic areas. In Mackinnon Ravine, the bottomland understory has been replaced by a freeway roadbed, and in Groat Ravine, the bottomland understory has been replaced by a freeway. This freeway also separates hare habitats which is a detrimental factor. The disturbance by traffic may also be limiting.

4.1.3.5.16 White-tailed deer (Odocoileus virginianus). One female white-tailed deer was observed in Mill Creek Ravine study area (Figure 8), and tracks and pellets were located in Whitemud Creek Ravine study area. The young female encountered in Mill Creek Ravine may be the result of mature does forcing away young of the previous year during spring. These castoffs sometimes move away from their previous range in seeking home territories, and the river valley provides a natural route into the city. White-tails are able to live in close proximity to man and are particularly capable of colonizing agricultural land. Therefore, since there is sufficient habitat within Mill Creek Ravine, it is not surprising that white-tailed deer can be found there.

There is also a sufficient quantity of suitable habitat in Whitemud Creek Ravine to support white-tailed deer. However, no evidence of a resident population was found. It would be simple for deer to move into the study area from the south by moving down the valley from rural

areas or into the ravine from upstream along the North Saskatchewan River.

4.1.3.5.17 Moose (Alces alces). Moose tracks were found in sediment along Whitemud Creek in the summer of 1972. Within a week following this observation, a young moose became entangled in a chain-link fence in Groat Road Ravine.

Like deer, moose may follow the North Saskatchewan River Valley downstream from their more common range to the west. There is, however, no resident population of moose in any of the ravine study areas, and moose sightings within the city are only sporadic.

4.2 Recreation Investigations

This thesis contains two sections. The first is a description of habitat and wildlife within the four ravines which provide a potential resource for wildlife-based recreations. This second part of the thesis documents (1) citizens' management preferences for the ravines, and (2) the recreational uses made of the ravines. Emphasis is placed on providing information about wildlife-based recreation uses of the ravines.

4.2.1 Recreation Uses of Ravines

4.2.1.1 Number of Users

Seventy-one per cent of the respondents recreated in the ravines (Table 23), and Whitemud Creek was visited by

the most ravine users (57.7 per cent), whereas Mackinnon Ravine was used the least (20.4 per cent; Table 24).

4.2.1.2 Origin of Users

Most users of ravines (31.7 per cent) inhabited census tracts adjacent to Whitemud Creek Ravine. Only 19 per cent of the users were from census tracts adjacent to Mackinnon Ravine (Table 25).

With the exception of persons from the Mill Creek Ravine area, there was a tendency for persons to recreate in the ravine nearest them (Table 26).

4.2.1.3 Recreational Activities

Most ravine users (72.5 per cent) used the ravines for walking. The second most popular activity was partaking in sports as indicated by 49.3 per cent of the users. The ravines were least used for studying wildlife and for fishing. Only 7 per cent of the users used the ravines for each of these activities. Wildlife observation was more popular than wildlife study (Table 27).

Non-ravine users gave several reasons for not recreating in the ravines. Most (36.2 per cent) did not know of the recreation potential of ravines. Others (3.4 per cent) thought ravines to be undesirable places for the following reasons: (1) the abundance of mosquitoes; (2) unsafe conditions imposed by traffic and persons under the influence of alcohol; and (3) unclean conditions in the ravines. Other

TABLE 23

NUMBER OF RAVINE USERS AND NON-USERS

	Number	Per Cent
Users	142	71
Non-Users	58	29
Total	200	100
Wildlife Users	30	15

TABLE 24

NUMBER OF PERSONS INDICATING THEIR USE OF THE RAVINE STUDY AREAS

Ravine Study Area	Number	Per Cent
Mackinnon	29	20.4
Mill Creek	43	30.3
Whitemud Creek	82	57.7
Groat Road	53	37.3

TABLE 25

NUMBER OF RAVINE USERS RESIDING IN EACH SAMPLE AREA

Ravine Sample Area	Number	Per Cent
Mackinnon	27	19.0
Mill Creek	34	23.9
Whitemud Creek	45	31.7
Groat Road	36	25.4
Total	142	100

TABLE 26

STUDY AREAS INHABITED BY USERS, AND RAVINES THEY USED

Study Area Inhabited	Ravine Used									
	Mackinnon		Mill Creek		Whitemud Creek		Groat Road		Total	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Mackinnon	20	52.6	1	2.6	7	18.4	10	26.3	38	100
Mill Creek	0	0	31	37.3	44	53	8	9.6	83	100
Whitemud Creek	1	1.8	3	5.5	44	80	7	12.7	55	100
Groat Road	8	13.1	8	13.1	17	27.8	28	45.9	61	100

TABLE 27

PARTICIPATION IN RECREATION ACTIVITIES

Activity	Number	Per Cent of Total Users
Walk	103	72.5
Partake in Sports	70	49.3
Picnic	64	45.1
Observe Wildlife	35	24.6
Ride	29	20.4
Study Wildlife	10	7.0
Fish	10	7.0

TABLE 28

REASONS FOR NON-USE OF RAVINES FOR RECREATION

Reason	Number	Per Cent
Too busy, not interested	21	36.2
Spend leisure time elsewhere	10	17.2
Unfamiliar with recreation potential of ravines	10	17.2
Lack of access or transportation	5	8.6
Too old an age to enjoy	4	7.9
Ravines too crowded or confined	2	3.4
Lack of facilities	1	1.7
Other	7	12.0
Total	58	100

reasons are presented in Table 28.

4.2.1.4 Seasonal Use and Frequency of Use

In both summer and winter seasons, most users visited the ravines five or more times per season. This tendency was, however, more pronounced in summer than in winter (Table 29).

4.2.1.5 Wildlife-Based Recreations

Ninety-six per cent of the users claimed that the potential of encountering wildlife in the ravines enhanced their recreation experience (Table 30). Fifteen per cent of the respondents or 22 per cent of the users specifically used the ravines to study or observe wildlife (Table 23). Accessibility of ravines and their uniqueness attracted wildlife users to them rather than to elsewhere (Table 31). Most of the non-wildlife users were not interested in (41.8 per cent) or knowledgeable about (23.6 per cent) the presence of wildlife in city ravines (Table 32).

4.2.2 Management Preferences

The pattern of recreation uses of an area are, to a large extent, a result of the facilities and opportunities provided by recreation managers. It is possible that recreationists' management preferences differ from their recreational activities in an area. For this reason, it is important to isolate the two in order that recreation

TABLE 29

FREQUENCY OF RAVINE USE IN SUMMER AND WINTER

Season	Frequency of Visits	Number	Per Cent
Summer	1 or less	9	6.3
	2-5	52	36.6
	>5	81	57.1
Total		142	100
Winter	1 or less	32	22.5
	2-5	52	36.6
	>5	58	40.9
Total		142	100

TABLE 30

RAVINE USERS THAT INDICATED WILDLIFE ENCOUNTERS WERE PLEASING

Answer	Number	Per Cent
Yes	137	96.5
No	5	3.5
Total	142	100

TABLE 31

REASONS FOR USE OF RAVINES FOR
WILDLIFE-BASED RECREATION

Reason	Number	Per Cent
Accessibility of ravines	22	70.9
Uniqueness of ravines	7	22.6
Exercise gained in conjunction	1	3.2
Other reasons	1	3.2
Total	31	100

TABLE 32

REASONS FOR NON-USE OF RAVINES FOR
WILDLIFE-BASED RECREATION

Reason	Number	Per Cent
Lack of interest	23	41.8
Unfamiliarity with ravines and features	13	23.6
Better locations elsewhere	10	18.2
Age handicapped	4	7.3
Ravines undesirable	3	5.5
Lack of access	2	3.6
Total	55	100

managers may better respond to citizens' preferences.

Results of the management preference analysis are presented in Table 33. The most preferred use was "to walk in the ravines in summer." The least popular preference was "to partake in recreation next to freeways."

Wildlife-oriented recreation such as watching wildlife films, visiting game farms, and reading books about wildlife were, in general, more preferable than wildlife-based recreation activities in the ravines.

Activities such as picnicking, partaking in sports and riding were more preferred uses of the ravines than were wildlife-based recreation uses.

Summer activities were more popular than winter activities.

Mammal-based recreation uses of the ravine were preferred to bird-based or insect-based recreation uses.

Summer activities involving wildlife were more popular than winter activities involving wildlife.

Activities involving wildlife observation were preferred to activities involving wildlife study.

There were no negative response scores (mean score > 1 but < 2.5) for any of the management statements, although there were several statements that received indifferent or neutral scores (mean score > 2.5 but < 3.5; Table 33).

TABLE 33

RESULTS OF MANAGEMENT PREFERENCE STATEMENTS

Statement	Mean Score	Rank
Walk in ravines in summer	4.40	1
Watch television programs about wildlife	4.21	2
Watch movies about wildlife	4.12	3
Picnic in ravines in summer	4.08	4
Observe mammals in ravines in summer	4.00	5
Study or observe wildlife in zoos or at game farms	3.96	6
Ride in ravines in summer	3.86	7
Read books or magazines about wildlife	3.78	8
Observe songbirds in ravines in summer	3.78	8
Observe mammals in ravines in winter	3.74	9
Observe other birds in ravines in summer	3.66	10
Partake in sports in ravines in summer	3.64	11
Walk in ravines in winter	3.62	12
Observe other birds in ravines in winter	3.57	13
Observe songbirds in ravines in winter	3.55	14
Study mammals in ravines in summer	3.40	15
Drive an automobile for recreation	3.32	16
Study mammals in ravines in winter	3.26	17
Fish in Whitemud Creek in summer	3.24	18
Observe or study wildlife from an auto	3.23	19
Hunt or fish for fish and wildlife	3.19	20
Study other birds in ravines in summer	3.19	20
Study songbirds in ravines in summer	3.18	21
Study other birds in ravines in winter	3.10	22
Study songbirds in ravines in winter	3.08	23
Observe insects in ravines in summer	2.99	24
Ride in ravines in winter	2.97	25
Observe or study wildlife next to a freeway	2.93	26
Study insects in ravines in summer	2.87	27
Partake in recreation next to freeways	2.52	28

4.2.3 Demographic Characteristics of Users and Non-Users

4.2.3.1 Sex Distribution

Sex distribution of ravine users and non-users is shown in Table 34. Forty-eight per cent of the users were male and 52 per cent were female.

4.2.3.2 Age Distribution

The majority of the ravine users were between the ages of 25 and 54. Age distribution of ravine users is presented in Table 35. For comparative purposes, this table also shows (1) the age distribution of some wilderness recreationists in the United States, and (2) age distribution of the metropolitan Edmonton population.

4.2.3.3 Occupations

The occupations of ravine users is shown in Table 36. The greatest percentage of ravine users were students and housewives.

4.2.3.4 Education of Ravine Users

The educational attainment of ravine users and other comparative populations is shown in Table 37. The majority of ravine users (57 per cent) had attained a high school level education or less. Note, however, that 23 per cent of the users were high school age or younger.

TABLE 34

SEX RATIOS OF RAVINE USERS AND NON-USERS AND OTHER POPULATIONS

Group	Sex					
	Male		Female		Total	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Users	68	47.8	74	52.1	142	100
Non-Users	28	48.3	30	51.7	58	100
*Metro Edmonton	248,620	50.2	247,080	49.8	495,700	100
**Washington State Pheasant Hunters		97.2		2.8		100

*Source: Statistics Canada (1971)

**Source: Potter et al. (1973)

TABLE 35

AGE DISTRIBUTION OF RAVINE-USERS AND OTHER POPULATIONS

Population	Age Group (Years)							
	0-15	16-18	19-24	25-34	35-54	55-64	65+	Total
	Per Cent							
Ravine Users	16	5	20	30	23	4	2	100
U.S. Wilderness*	3	7	12	24	46	6	2	100
Users								
Metropolitan Edmonton**	35	6	7	16	23	7	6	100
U.S. Population*	33	4	8	13	24	9	9	100

*Source: Hendee et al. (1968).
**Source: Statistics Canada (1972)

TABLE 36

DISTRIBUTION OF RAVINE USERS' OCCUPATIONS

	Occupation								
	Professional	Business and Managerial	Clerical	Craftsman	Laborer	Retired	Housewife	Student	Total
Users	18	15	10	8	6	0	20	23	100

TABLE 37

RAVINE-USERS' AND OTHER POPULATIONS' LEVEL OF EDUCATION

Population	Public School	Secondary School	Technical School	University	Total
	Per Cent				
Ravine users	20	37	7	36	100
*Metropolitan Edmonton	50	27	12	11	100
**U.S. wilderness users	------- 36.3 -------		------- 63.7 -------		

*Source: Statistics Canada (1972)
**Source: Hendee et al. (1968)

TABLE 38

DISTRIBUTION OF DWELLING TYPES OF RAVINE USERS

Population	Apartment (Walk-up or High Rise)	Single Detached or Attached	Total
	Per Cent		
Ravine user	32	68	100
*Metropolitan Edmonton housing types	30	70	100

*Source: Statistics Canada (1972)

4.2.3.5 Dwelling Types

As shown in Table 38, the majority of the ravine users occupied single attached or detached dwellings.

4.2.3.6 Length of Edmonton Residency

Most ravine users (58 per cent) had resided in Edmonton 10 years or more. Eight per cent had resided in Edmonton 2 years or less (Table 39).

4.2.3.7 Annual Family Income

The greatest percentage of the ravine users had family incomes of $15,000 or more. The majority of ravine users had family incomes greater than $10,000 (Table 40).

4.2.3.8 Ownership of Vacation Homes

Nineteen per cent of the ravine users were members of a family that owned a vacation home (Table 41).

4.2.3.9 Number Who Hunted or Fished

As shown in Table 42, a large majority of both ravine users and non-users neither hunted nor fished.

TABLE 39

RAVINE USERS' LENGTH OF RESIDENCY IN EDMONTON

Population	2 yrs or less	2-5 yrs	5-10 yrs	10 yrs or more	Total
	Per Cent				
Ravine Users	8	13	20	58	100

TABLE 40

RAVINE USERS' ANNUAL FAMILY INCOME

Population	<$2,000	$2,001-$6,999	$7,000-$9,999	$10,000-$14,999	$15,000 or more
	Per Cent				
Ravine users	5	15	20	27	33
*Metropolitan Edmonton family incomes	4	24	25	30	17

*Source: Statistics Canada (1972)

TABLE 41

OWNERSHIP OF VACATION HOMES BY RAVINE USERS

Population	Own Vacation Home Per Cent	
	Yes	No
Ravine users	19	81
Non-users	16	84

TABLE 42

NUMBER OF RAVINE USERS AND NON-USERS WHO HUNT OR FISH

	Answer			
	Yes		No	
	Number	Per Cent	Number	Per Cent
Users	28	20	114	80
Non-users	9	16	49	84

CHAPTER 5

DISCUSSION

5.1 Biological Investigations

5.1.1 Vegetation and Wildlife Habitat

Bird (1961) places Edmonton within the aspen parkland vegetation zone, but because of the cool north-facing slopes in the ravines, many plant species in the study areas are also typical of the boreal mixed wood forest. This is seen in the presence of white spruce, white birch, balsam poplar and trembling aspen within the ravines, all of which are principal boreal forest species (Rowe 1972). Soper (1964) described some areas of the aspen parkland that include intrusive stands of white spruce and white birch within river valleys. Edmonton's ravines fall into this category.

Understory species present in the ravines that are characteristic of such forests are snowberry, wild rose, highbush cranberry (*Viburnum trilobum*), buffalo-berry (*Shepherdia canadensis*) and silver-berry (Soper 1964).

Tree species in the ravines that are characteristic of the aspen parkland are trembling aspen, balsam poplar and white birch. Ravine understory species that are typical of aspen parkland include: beaked hazelnut, red osier dogwood, chokecherry, saskatoon, and raspberry (Bird 1961).

In summary, the vegetation of the ravines is composed of boreal mixed wood and aspen parkland species. Plant communities representative of both biomes are present principally because of the contrasting site conditions created by the abrupt topography of the river valleys and the corresponding influence of aspect. Cool and moist north-facing slopes are characterized by white spruce associations, warm and dry south-facing slopes by grasslands or shrublands. Flats and terraces are normally occupied by mixtures of balsam poplar and trembling aspen. Valley bottoms contain riparian stands that include balsam poplar, willow and alder. (Alders were absent adjacent to Mill Creek but were abundant near Whitemud Creek where stands up to 7 m tall were common.)

Vegetation distribution within the ravines thus changes quickly in response to a variety of environmental factors. The overall result is an abundance of "edge" which helps provide good wildlife habitat. The habitat diversity that occurs in a relatively small area makes the ravines suitable for interpretive nature programs where the effects of such environmental factors as aspect and slope angle could be explained as well as the habitat preferences of certain animals.

The great habitat diversity of the ravines thus supports a diversity of wildlife. An abundance of fruit-bearing shrubs (in shrubland habitats and as understory in other habitats) provides food for fructivorous bird species and

other wildlife. Some of these shrubs (saskatoon, pin-cherry and chokecherry) are also palatable as browse for wild ungulates (Taylor 1956). There is a sufficient quantity of red osier dogwood, a favoured deer browse, to support a permanent deer population. Although this species was not observed to be browsed within the present study area, it was found to be browsed by deer in Kennedale Ravine (Spencer 1975).

Other plant species that are present in sufficient quantities to provide food for animals include seeds in white spruce cones and beaked hazelnuts for red squirrels, young aspen and willows for snowshoe hare, birch and willow for porcupine, trembling aspen and willows near flowing water for beavers.

5.1.2 Inventory of Wildlife Species

5.1.2.1 Bird Species Diversity in Study Ravines

The following reasons are given for the presence or absence, or differences in total numbers, of bird species in the study ravines.

Free-flowing streams have been covered by freeway bases in Groat and Mackinnon Ravines. This may have deterred the more water-dependent species from using these sites. For instance, spotted sandpipers that are dependent on shorelines are present in Whitemud Creek Ravine, but not in the others. Woodpeckers (*Picidae* spp.), hawks (*Accipitridae* spp.),

and nuthatches (*Sittidae* spp.) that prefer mature forest bottomlands for parts of their life cycles may have been excluded from Groat and Mackinnon Ravines when mature, bottomland forests were removed in preparation for freeway construction. Bent (1964) writes that pileated woodpeckers (*Dryocopus pileatus*), present only in Whitemud Creek Ravine, require large tracts of mature forest and disappear from smaller tracts. Whitemud Creek meets these habitat requirements while the other ravines do not.

Rock doves (*Columba livia*) were absent from Whitemud Creek Ravine, but are present in Groat, Mackinnon and Mill Creek Ravines. They are more abundant in areas without a thick vegetation cover but have an abundance of concrete and a high density of buildings (Williamson 1974). Williamson (1974) also found that rock doves were more abundant in lower income areas. It seems that some monetary value may be placed on vegetation and the wildlife habitat it provides. Residential areas with an abundance of vegetation are more desirable to live in and therefore accommodate persons with higher incomes. Less desirable residential areas commonly lack abundant vegetation cover. The Whitemud Creek Ravine is not within a lower income area. Additionally, it is a greater distance from the concrete areas of the central business district that provide rock dove habitat than is Mill Creek Ravine or Groat Ravine.

Merlins (*Falco columbarius*) were present in all of the ravines in winter and nested in Mill Creek Ravine in summer. In winter, they prey upon bohemian waxwings and other winter residents that use the ravines for cover. The merlins were particularly observed to hunt bird feeding station areas where there were concentrations of winter residents.

Some species present are associated with surrounding uses of the land. For example, red-tailed hawks that nest in Whitemud Creek Ravine use for a food source small mammals and rodents that occur in adjacent agricultural fields. Gray partridge (*Perdix perdix*) that occur in Whitemud Creek Ravine use adjacent agricultural fields as habitat.

Most species of gulls are very mobile and California (*Larus californicus*), ring-billed (*Larus delawarensis*) and Franklin's (*Larus pipixcan*) gulls use airspace over all of the ravine study areas. The ravines are close to the North Saskatchewan River Valley where the birds loaf on shores and gravel bars. Gulls are observed far from loafing and resting spots in other areas as well. For example, they make long flights to garbage dumps to feed (Ward 1974).

5.1.2.2 Bird Numbers in the Study Areas

5.1.2.2.1 Ravines. For all bird groups tested, there was a significant difference in the number of birds between the four ravines. In all cases, Groat Road Ravine, the

ravine with the greatest freeway development, had the lowest average number of birds. Whitemud Creek Ravine, the one with the least freeway development, nearly always had the largest average number of birds for each of the bird groups tested. Several reasons are given below to explain these statistically significant differences.

Overall differences in habitat characteristics between the ravines can account for not only the differences in species composition between ravines, but also differences in total numbers. Some habitats may have larger carrying capacities for bird populations, so differences in size and quantity of habitat types in ravines may affect total bird numbers present.

There is more total habitat available to birds in Whitemud Creek and Mill Creek Ravines, the two largest study ravines. Therefore, bird species that have larger territorial requirements may prefer these to the smaller ravines such as Groat and Mackinnon. Whitemud Creek Ravine also has hay fields adjacent to its east bank which helps to account for the greater diversity and larger numbers of birds using it. In short, there is a habitat to be filled in this ravine that is not present in the others.

Some differences in the quality and quantity of ravine habitat are directly attributable to road construction. For instance, streams occupy Whitemud and Mill Creek Ravines while streams that formerly flowed in Groat and

Mackinnon Ravines have been covered by road beds. The absence of flowing water may have reduced the overall carrying capacity of the ravines as evidenced by the elimination of some species of spring and summer breeding birds.

Freeway-occupied open spaces in Groat and Mackinnon Ravines may restrict some birds' territories, particularly in the breeding season. Some birds may hesitate to expand their territories across such open spaces. The net result may be fewer territories and more linear-shaped ones in those ravines.

Automobile emissions can kill coniferous trees--particularly in basin-shaped areas. Because coniferous trees do not shed their leaves annually, noxious residues concentrate in their needles and may eventually cause their death (Bonnett 1970). Coniferous trees that died and were removed from Groat Ravine may have succumbed to these fumes. Trees lost to this cause represent an alteration of a habitat and may reduce number of some species. Automobile fumes may also be offensive to birds and prevent some individuals or species from using adjacent habitat they ordinarily would.

The physical presence of moving vehicles and their accompanying noise may also make Groat Ravine less desirable habitat for birds. Gollop et al. (1974) subjected ground-nesting passerines in the Arctic to noise disturbance and found that marginally more birds nested in undisturbed areas than in disturbed. Their experiment was initiated after

breeding territories had been established. In the Mackenzie Delta area, Barry and Spencer (1972) found that for some passerine species, there were significantly fewer birds in an area disturbed by oil well construction than in an area of no disturbance. In Groat Ravine, birds arriving in spring to initiate breeding territories may not establish territories because of the already-occurring disturbance. Gunn et al. (1974) re-surveyed Gollop et al's. (1974) study area one year later, and concluded that there were long-term effects of noise disturbance. In short, although differences in bird numbers may not be significant at the initial application of noise disturbance, birds in future years may not use the area as intensively as before.

The effect that freeway noise can have on an observer's ability to detect birds should also be considered in evaluating the results of noise disturbance. Some birds present in Groat Road Ravine may have gone undetected because they could not be heard over vehicle noise.

Some researchers found that there was little difference between the number of birds in developed and natural areas in cities. Some have even found greater populations in developed areas (Geis 1974). Erz (1966), Nuorteva (1971), and Cauley (1974) made similar observations. In nearly all of these studies, birds such as weaver finches (*Passer domesticus*), domestic pigeons, and starlings (*Sturnus vulgaris*) were the most numerous birds in the built-up areas. These

species thrive in locations where there is an abundance of man-made structures to which they have adapted.

Erskine (1974), in a study of winter birds in Ottawa residential areas, found there were more birds in older areas that had the greatest densities of vegetation. His study, however, concerned songbirds and did not include domestic pigeons, etc. Thomas et al. (1974) also found the type and structure of vegetation to be the greatest factor influencing bird densities in an urban area--even greater than such factors as presence of dogs and cats, traffic volume, human presence and buildings.

The situation in the present study differs somewhat from those cited above. Man-made bird habitat has not yet been constructed in Groat Road and Mackinnon Ravines in sufficient quantity to attract large numbers of house sparrows, domestic pigeons and starlings. There is as much habitat for these birds in the form of bridges and pipelines traversing Whitemud Creek and Mill Creek Ravines as in Mackinnon and Groat. Disturbance in the form of freeway right-of-way clearing and freeway operation in Groat Ravine may have been sufficient to eliminate some birds. This is probably the most significant factor influencing the difference in the number of birds using the four study ravines.

5.1.2.2.2 Seasons. The variable of seasons had a significant effect on the number of birds observed for the following bird groups: (1) all birds including bohemian

waxwings, and (2) jays, magpies and crows. An obvious cause for differences in total number of birds for each of the seasons is the migration behaviour of birds. Many of the species that are common summer residents and breeders migrate during winter so that numbers are reduced.

The combination of locally breeding birds and spring migrants that pass through Edmonton during spring and fall may also explain differences in numbers between seasons.

Bohemian waxwings, pine grosbeaks *(Pinocola enucleator)* and evening grosbeaks, and species of redpolls (*Acanthis* spp.) and crossbills (*Loxia* spp.) breed in the boreal forest and tundra regions (Godfrey 1966). Variable numbers of these birds winter in the vicinity of Edmonton, being attracted to the city by a number of urban habitat-related factors: (1) warmer micro-climate; (2) abundance of ornamental fruit trees that provide a food source; (3) availability of food at bird feeders provided by citizens; and (4) location of escape cover in the form of ravines adjacent to food sources.

In Mackinnon Ravine, where there are a number of bird feeders adjacent to the ravine, it is not uncommon to observe concentrations of hundreds of bohemian waxwings and evening grosbeaks around a feeder. The winter populations may be large enough to account for seasonal differences in numbers of birds.

Seasonal differences in the number of jays, magpies and crows can result from the annual increment that is part

of the population in winter. Offspring that result from the breeding season may temporarily increase the total population until natural causes reduce the population to its pre-breeding season low.

5.1.2.2.3 Habitats. Significant differences in the numbers of birds in ravine habitats, the interaction of habitats and ravines, and interaction of habitats and seasons occurred.

These differences can be explained by:

1) the preference some bird species have for specific habitats;
2) the greater availability of food in particular habitats;
3) the visibility factors afforded by some habitats for the observer;
4) the proximity of some habitats to human-induced conditions favourable or unfavourable to birds; and
5) differences in the understory plant compositions in like habitats.

Mixed wood forest habitats are more favoured by breeding birds than are deciduous forest habitats. Mixed wood forests in this study contained the most birds in the winter season--whether waxwings are included in or excluded from the analyses (Table 43). Mixed wood forest also had the most birds in spring.

In all three field seasons, the most productive habitat in terms of the average number of birds encountered

TABLE 43

RANKING OF NUMBER OF BIRDS* BY SEASON IN HABITATS

Habitat	Season							
	Winter	Rank	Winter**	Rank	Spring	Rank	Summer	Rank
Grassland	42	7	195	4	173	2	253	1
Shrubland	42	7	154	5	126	6	120	7
White Spruce	96	4	212	3	87	8	127	6
White Spruce-Poplar	139	1	259	2	189	1	234	2
White Spruce-White Birch	98	3	212	3	129	5	189	3
Poplar	75	5	127	6	121	7	114	8
Poplar-White Birch	73	6	109	7	135	4	134	4
Dead Tree	109	2	562	1	139	3	131	5

*Observed in four ravine study areas in six visits.
**Including waxwings.

in a single visit, was the white spruce-poplar association. Most productive habitats for the sum of all birds were derived in the following manner. For each field season, the total numbers of birds observed in specific habitats for each of the ravine study areas were summed. The sums for each habitat were then ranked in descending order, the highest total representing the most productive habitat for that particular season. Table 43 displays the results of this process.

The white spruce component of a mixed wood forest provides a food source for many birds. For example, the insects and the larvae in the bark are favoured by black-capped chickadees, species of crossbills and woodpeckers (Martin 1961).

There were large numbers of birds observed in dead tree plots during the winter field season. In Mackinnon Ravine, these plots were located in an area adjacent to bird feeders, where large numbers of waxwings in particular used the trees for perching between sessions at the bird feeders. In addition, greater visibility for the observer in the dead tree plot made birds using the airspace over the habitat more detectable. This same visibility factor could explain the high ranking of grassland habitat for birds observed in spring and summer seasons. Another explanation is the preference that birds show for edge habitat provided by grassland clearings. Lay (1938) claims that edge effect

increases bird numbers in an area.

5.1.2.3 Gallinaceous Birds

5.1.2.3.1 Ring-necked pheasant. In Mill Creek Ravine there is a relative abundance of pheasants even though rural populations of the bird are low. In Mill Creek Ravine, ring-necked pheasants seem to have adapted well to the urban environment and use all suitable habitat.

Hunted rural populations of the birds have cock-hen ratios in spring of 1:6 (Edminster 1954). The cock-hen ratio of Mill Creek Ravine (1:1) is not atypical of unhunted populations. (Care should be exercised in the interpretation of cock-hen ratio results for Mill Creek Ravine however, as the small number of bird groups contacted provides only a small sample size upon which to base estimates.)

From the estimate of 22 birds in the approximate 209 ha of Mill Creek Ravine study area, a calculated spring density of 9.5 ha per bird falls just short of third class range (Edminster 1954). Assuming normal life equations, in autumn one could expect a resultant 64 birds.

Pheasants detected by auditory and visual means in Groat and Mackinnon Ravines could have been transient birds that also use the main river valley as habitat. It was not determined whether pheasants successfully nested in these two ravines.

At a time when the upper parts of the Whitemud Creek Ravine study area were outside the Edmonton corporate limits, pheasants were hunted there. Now, no pheasants inhabit the ravine. Reasons for their absence could be that fields surrounding the ravine have been converted to housing developments; secondly, the University of Alberta farm property was planted to hay rather than grain during this study.

5.1.3.3.2 Ruffed grouse. The low numbers of grouse may be a result of a low in the cyclical population fluctuation (Keith 1963).

Whitemud Creek Ravine, with its mature forest bottomland, appears to afford the better ruffed grouse habitat of the four ravine study areas. Assuming a 1:1 cock-hen sex ratio, there was probably a spring grouse population of four in this ravine study area. The population could have expanded to 16 by August assuming a hatch of six fledged chicks per hen (Edminster 1954). Rusch et al. (1972) cite the average clutch size at Rochester, Alberta (near Edmonton) at 12. Taking into account mortality as a result of climatic and predatory factors, this number would be considerably reduced by autumn.

Although no ruffed grouse were detected during the course of this study in Mackinnon Ravine, the birds were present in the mid-1960's. Shortly after that time, a major part of the forest cover in the bottomlands was removed in preparation for freeway construction.

Assuming grouse and pheasant to be equally vulnerable to predation, the fact that a large population of pheasants inhabit Mill Creek Ravine would seem to discount predation as being a limiting factor on grouse. More likely, pheasants are more tolerant of the proximal urban environment. In addition, pheasants may be more tolerant of the linear habitat provided by narrow ravines.

5.2 Recreation Investigations

The questionnaire was designed to detect citizens' preferences for recreation management of the ravines and also to determine the actual recreation uses made of the ravines. In order to avoid redundancy, discussions of actual uses and preferred uses are combined.

5.2.1 Number of Users

Questionnaire results indicate a large proportion of citizens use ravines for recreation. Reasons for such use include the following:

1) a large portion of the city's parks development is based in the North Saskatchewan River Valley, of which the ravines are an integral part;
2) the questionnaire was circulated in areas adjacent to ravines. Ravines are more accessible to the sample population than to all citizens. However, the central location of the river valley and ravine system does make them accessible to most citizens; and

3) parks managers have provided facilities for a variety of recreations in the river valley system, some of which do not require river valley settings. This is particularly true of Whitemud Creek Ravine where there are, or were at one time, facilities for skiing, skating, picnicking, nature walks, nature interpretation, camping, and horse-back riding. The combination of river valley aesthetics and the parks managers' evident policy of providing a multitude of recreational facilities in the river valley attracts almost everyone.

Because Whitemud Creek has many more facilities for recreation than others, and because it was also used as a study ravine, the reliability of the measure of use of city ravines could be affected. Certainly not all ravines have as many facilities and therefore do not attract as many persons. For example, Mackinnon Ravine has no facilities save its natural setting and receives the least use.

Results indicate that Groat Ravine, a valley lacking in facilities, receives heavy use. However, this use may not be so heavy as it appears, because some respondents probably included in their interpretation of the boundaries of Groat Ravine the area below the provincial archives building (Figure 9). This area is used for picnicking, hang-gliding and sliding. There are no such facilities in the ravine proper.

5.2.2 Origin of Users

Data about respondents' characteristics indicate that income-related variables influence use of ravines. Census tracts surrounding Whitemud Creek Ravine are made up of a rather affluent population and this could account for the large number of ravine users who originate from Whitemud Creek Ravine study area. The tendency for recreationists to use the ravine nearest them, combined with the variety of recreation facilities in Whitemud Creek Ravine, attracts residents of that area. The lack of facilities in Mackinnon Ravine and the destruction of bottomland could make it the least desirable for recreation.

5.2.3 Actual and Preferred Uses

As well as being the most popular management preference, "walking in the ravines" was the activity participated in by the most persons. This is an indication of the ease with which this activity is done. Less popular activities such as organized sports and "riding" as defined in Appendix B require some specialized equipment and prior preparation. Use of the ravines five or more times per season combined with use of the most accessible ravine indicates further that ravines are convenient places for leisurely strolls.

"Partaking in sports" was determined to be the second most popular actual use made of the ravines. This result possibly reflects the wide range of facilities provided in Whitemud Creek Ravine.

The tendency for respondents to prefer a variety of other recreations being conducted in the ravines over wildlife-based ones confirms the Edmonton Parks and Recreation Department's policy of including such recreational amenities as ski hills, picnic areas and skating rinks in urban ravines. In answering the questionnaire, respondents may have extended their general likes and dislikes of various recreation activities to the ravine setting.

Citizens indicated that they used the ravines for recreation more often in summer. They also preferred summer-related recreations over winter-related recreations as the summer season allows a greater variety of recreations and more citizen participation. If a management objective is to increase winter use of the ravines, more facilities such as skating rinks and ski hills could be provided. But these should be provided only in those locations where they are not detrimental to an important wildlife resource. Since the completion of data collection for this project, there has been a general increase in the popularity of such winter recreations as cross-country skiing and snowshoeing in the ravines. This trend should continue as such socio-economic conditions as increased transportation costs produce a greater demand for locally available types of recreation.

Recreating next to freeways received the lowest ranking of the management preferences indicating that persons did not appreciate proximity to freeways in comparison to

other preference statements that were provided. This has obvious implications for city planning departments to avoid constructing freeways and recreation facilities in the same open space such as a ravine.

Data about user characteristics indicated a large percentage of non-users have not resided long in Edmonton and are unfamiliar with the recreation resource ravines can provide. If Edmonton Parks and Recreation wished to increase the use of facilities in the ravines, which may or may not be desirable, a public information program concerning their recreation potential could be directed at new citizens.

5.2.3.1 Wildlife-Based Management Preferences and Recreations

Only a small percentage of respondents indicated they used the ravines for wildlife study. However, when the results of this sample are extrapolated to the metropolitan population, it appears a significant total. Individuals who are greatly intrigued by wildlife probably travel to more natural habitats. Schweitzer et al. (1973), for example, found rural areas to be more popular for bird study than urban areas.

A large percentage of ravine users were pleased by wildlife encounters in ravines although these were not their major objective in visiting ravines. Lime (1969) made a similar finding in a study of campers, and Dagg (1974),

during a survey of urban residents, found a similarly favourable attitude toward urban wildlife. The actual wildlife-based recreation uses and the propensity for wildlife contact demonstrated by users indicate a general acknowledgement of the importance of wildlife in the ravine areas.

The popularity of reading books and magazines about wildlife, viewing wildlife films, and viewing captive animals rather than viewing wildlife in natural areas indicates a preference for vicarious uses of wildlife. Many people seem inclined to view wildlife in artificial rather than natural settings.

Ravine managers can do little about the lack of interest in urban wildlife as indicated by non-users. Recently, however, there has been a growing interest in the environment, ecology, wildlife and related subjects. This interest is likely to continue to grow and park managers will have to respond to increasing demands for wildlife-based recreations in city ravines. Factors such as energy shortages are likely to compound these demands. Already, a nature centre has been constructed in Whitemud Creek Ravine, one has been proposed by parks planners for Hermitage Park (Environtec Design Group 1975) and the Parks and Recreation Department is investigating the effects of an insect spraying program on avifauna (J. C. Finley, pers. comm. 1975).

Citizens indicated a preference for mammal-based recreation over bird-based recreation. However, songbirds

are probably better suited to urban wildlife management because of their attributes of high visibility due to colour, song, mobility and variety, and their general lack of offensiveness (DeGraff 1974). Mammals are also more difficult to manage in urban areas, although it should be taken into consideration that many residents, such as those in California (Gill 1965) and Ontario (Dagg 1974) indicate a liking of them. Often, home ranges of mammals are too large for the areas that are set aside as habitat in urban areas. Some mammalian species are destructive. Nevertheless, there are trade-offs to be had by including such potentially destructive animals as beavers in an urban wildlife management program.

Some of the results obtained by Schweitzer et al. (1973), in a study of management preferences of Saskatchewan citizens for birds, are comparable with those obtained in this study. Schweitzer et al. (1973) found that although the differences were not statistically significant, citizens preferred to observe birds in urban areas and preferred to study birds in rural settings. The same study indicated that songbirds were preferred over a variety of other bird groups for observation and non-consumptive recreationists. The present study determined the same tendency.

Respondents to this questionnaire (Appendix B) showed a greater preference for wildlife observation in the ravines than for wildlife study. Schweitzer et al. (1973)

determined a similar preference.

5.2.4 Demographic Characteristics of Users and Non-Users

5.2.4.1 Sex Distribution

The sex distribution of the ravine users was similar to that of the metropolitan Edmonton population (Table 34). There was no difference between the sex distribution of users and non-users. Gender is not so determining a factor in one's partaking of non-consumptive recreations as it is in one's partaking of consumptive recreations. For example, Potter et al. (1973) found far more males were pheasant hunters than females. A greater cross-section of society accrues the benefits of the non-consumptive recreations (Hendee 1969).

5.2.4.2 Age Distribution

As was the case with a sample of American Wilderness users (Hendee 1968), the majority of ravine users was between the ages of 25 and 54. Compared to the metropolitan Edmonton populations, users in the 0-15 age class were under-represented. The age group between 19 and 34 years was over-represented in the ravine users when compared with the metropolitan Edmonton population. This represents the natural tendency for younger persons to partkae in active ravine recreation.

5.2.4.3 Occupations

Comparable data from Statistics Canada were not available for all occupation classifications. By pooling selected 1971 Canada census classifications, some comparisons could be made with metropolitan Edmonton. As shown in Table 44 it appears that clerical workers are slightly over-represented and business and managerial persons slightly under-represented.

5.2.4.4 Education

Compared to the metropolitan Edmonton population, persons whose highest level of education was public school were under-represented. Persons with secondary school and university education were over-represented. By pooling some ravine user education classifications, comparisons can be made with a sample of United States wilderness recreationists (Table 37). Persons whose highest level of education is public or secondary school are over-represented in comparison and persons with technical school or university backgrounds are under-represented. The reason for this is the specialized nature of wilderness recreation as opposed to the various sorts of more general recreation available in the ravines.

Because of the discrepancy between the education levels of ravine users and the metropolitan Edmonton population, ravine managers should consider a public information

TABLE 44

DISTRIBUTION OF RAVINE USERS THAT ARE PROFESSIONALS, BUSINESS AND MANAGERIAL PERSONS AND CLERICAL WORKERS

Population	Occupation		
	Professional	Business and Managerial	Clerical
Ravine user	42	35	23
*Metropolitan Edmonton	42	42	16

*Source: Statistics Canada (1972)

program designed to inform those with a lower education level of the ravines' recreation potential.

Present data about user education attainment suggest that fairly detailed interpretive nature displays and programs could be comprehended.

5.2.4.5 Dwelling Type

When designing the questionnaire for the present study, it was hypothesized that apartment dwellers would use the ravines more than dwellers of single detached and attached residences. It was assumed that residences with backyards had space for some recreation whereas apartments lacking green space provide little room for outdoor recreation, which would induce recreation seekers to such localities as ravines. The findings disproved this hypothesis. Residents of single detached or attached homes tended to use the ravines more than others. Several reasons for this are the following:

1) some apartments supply recreational facilities in the form of swimming pools, billiard rooms, exercise rooms, etc., that provide a recreational outlet for tenants;
2) housing type is an indicator of financial and educational attainment. These variables were found to be more important predictors for use or non-use of the ravines (Appendix A); and
3) the ravines used for study in this project were not as

accessible to apartments as they were to single detached or attached residences.

5.2.4.6 Length of Edmonton Residency

Persons who have resided in Edmonton longest are consequently more knowledgeable about the ravines as recreation areas and therefore use them more than shorter-term residents. Some who have resided in Edmonton five years or less are young persons who are not yet fully capable of taking part in all the recreation possibilities in the ravines. Comparable information about the length of residency of the metropolitan Edmonton population is not available.

5.2.4.7 Annual Family Income

The majority of the ravine users was from families that had annual incomes greater than $10,000. By comparison, the majority of metropolitan Edmonton families had an income in 1971 greater than $7,000 but less than $15,000. Users from higher income families are over-represented. Following are several reasons given to explain this situation:

1) persons who are users are those who have easiest access to the ravines. Homes that are nearer the ravines generally have higher real estate values than those farther away;
2) persons with higher incomes are generally more mobile in gaining access to the ravines; and

3) income level and education are positively correlated and highly educated persons are more likely to make use of the ravines.

5.2.4.8 Ownership of Vacation Homes

During questionnaire design, it was hypothesized that persons who own vacation homes will use the ravines less because such homes provide an alternative to the ravines. This hypothesis was disproven, as it was learned that slightly more ravine users own vacation homes than non-users. The fact that more users own vacation homes is probably a further reflection that income-related variables are a more important force in determining a person's use or non-use of the ravines.

5.2.4.9 Number of Users Who Hunt or Fish

Schweitzer (1973) found that game bird hunters, bird observers and persons who study birds for recreation are separate groups for which the resource must be managed separately. The present study found similar results, in that few ravine recreationists hunted or fished.

CHAPTER 6

CONCLUSIONS

6.1 Limitations of the Data

It is important to consider several limited factors in interpreting some of the data generated by the methods employed in this research.

A search of literature concerning the snowshoe hare was made but information about the number of fecal pellets produced in a 24 hour period by the snowshoe hare was unavailable. In determining snowshoe hare densities, a figure for eastern cottontail fecal pellet production (Cochrane and Staines 1961) was extrapolated to snowshoe hare pellets counted in the study plots. Pellet production probably varies between species.

The recreation questionnaire was circulated in residential areas that surrounded the study ravines. Although responses were solicited from residences up to 1.5 km distant from the ravines, on the average respondents lived closer to the ravines than most Edmonton residents. This may have biased the results in two ways:

1) The ravines are more accessible to those living closer to them. Results showed that 71 per cent of the respondents used the

ravines for recreation. Had the questionnaire been circulated amongst a random sample of Edmonton's population, this percentage may not have been so high.

2) Ravines are desirable features to live near. As a result, higher income earners may inhabit these areas and therefore be over-represented in the questionnaire respondents.

6.2 Summary

A summary of the major findings of the thesis follows:

1) The study determined that there were more diversified and larger bird populations in ravines with the least road development. Road development in the ravines may decrease bird populations and consequently the quality of wildlife-based recreation in them.
2) In all seasons investigated, the most birds were detected in mixed forest habitats.
3) Gallinaceous birds were not abundent in the ravine study areas except for Mill Creek Ravine. In Mill Creek Ravine there was an abundance of ring-necked pheasants.
4) A variety of mammals inhabit the ravines,

including some species that are more traditionally considered rural. Such species include white-tail deer, Canada lynx and coyote. Insufficient numbers of mammals were detected in the ravines to make strong conclusions about the effects of freeway development on their populations.

5) Seventy-one per cent of the respondents indicated they used the ravines for recreation and Whitemud Creek Ravine was visited by the most respondents.

6) Wildlife-based recreations were participated in the least by respondents, however, 96 per cent indicated that encounters with wildlife in the ravines made their visits to them more pleasant.

7) The respondents preferred other activities over wildlife-based ones.

8) Respondents preferred wildlife-based recreations that involved mammals.

9) Data about the demographic characteristics of respondents indicated that income related variables govern whether or not a person is a ravine user. Persons from families with

higher incomes that also have accompanying variables such as ownership of a single detached home and higher level of education are more likely to be ravine users.

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APPENDICES

APPENDIX A

STATISTICAL ANALYSIS OF DEMOGRAPHIC PREDICTOR VARIABLES FOR USERS AND NON-USERS

Statistical Procedures

The statistical method applied to examine the relationships between use or non-use of the ravines and demographic characteristics of the respondents was a stepwise multiple discriminant analysis (SMDA). This analysis was performed by a computer using the program BMDO7M (Dixon 1968). The predictor variables from the questionnaire that were tested are listed in Table 45.

Multiple discriminant analysis is applicable when a dependent or criterion variable (use or non-use in this case) that has been measured on a categorical or coarsely graduated scale is believed to have been affected by several predictor variables (Gollop et al. 1974).

In stepwise multiple discriminant analysis, predictor variables are added one at a time to the multivariate model in descending order of statistical relationship to the dependent variable. Addition of predictors to the model continues until the inclusion of no other variable would significantly improve the predictability of the dependent variables (Gollop et al. 1974).

These procedures were completed first including the predictor variable of whether the respondent was a student

TABLE 45

PREDICTOR VARIABLES TESTED USING STEPWISE MULTIPLE DISCRIMINANT ANALYSIS

1. Sex
2. Level of Education
3. Dwelling Type
4. Length of Residency in Edmonton
5. Annual Income
6. Ownership of Vacation Home
7. Age
8. Occupation

or not and then excluding this variable.

Including Students

The first step of the program (a one-way analysis of variance of each of the variables conducted independently) determined that dwelling types ($0.05 \geq p > 0.01$) and income and age were predictors ($0.1 \geq p > 0.05$). Users tended to live in single-detached dwellings, to earn more than non-users, to be not craftsmen, tended to be younger and students.

In the second step or simultaneous examination of the variables, education ($p \geq 0.1$), income, whether a person was a craftsman and whether a person was a student were determined to be best predictors of a person's use or non-use of ravines. Once income was considered, dwelling type became unimportant, probably because the two are positively correlated. Education became important only after whether a person was a student or not was considered. These variables are also positively correlated. By taking into account the variables of education, income, craftsman or not and student or not, one ought to be able to predict to the $p \geq 0.001$ level whether a person is a user or not. This was done using the data collected in this study. Of the 142 actual users, the model would have predicted 98 to be users and 44 to be non-users. Of the 58 non-users, the model would have predicted 24 to be users and 34 to be non-users.

Excluding Students

The first step of the program or one-way analysis of variance determined that the variables of education ($0.01 \geq p > 0.001$), income ($0.01 \geq p > 0.001$), whether a person was a professional or not ($0.05 \geq p > 0.01$), and whether a person was a craftsman or not ($0.05 \geq p > 0.01$) were statistically significant predictors of a person's use or non-use of the ravines.

In the second step, level of education ($0.01 \geq p > 0.001$), length of residency ($0.05 \geq p > 0.01$), whether a person was retired or not ($0.05 \geq p > 0.01$) were determined to be statistically significant predictor variables. Users tended to be more highly educated, long-time residents, not craftsmen and not retired.

Once education was considered in the model, the fact that a person was a long-time resident became important as did whether a person was retired or not.

When one considers these variables, the degree of predictability of the indicators is significant to the $p > 0.001$ level. The predictors were tested using the data from the questionnaire. Of the actual users (excluding students) 79 were predicted to be users and 31 non-users. Of the actual non-users (excluding students), 23 were predicted to be users and 31 non-users.

APPENDIX B

EDMONTON RAVINES RECREATION SURVEY

DEPARTMENT OF GEOGRAPHY, UNIVERSITY OF ALBERTA

Part of the City of Edmonton's parkland is located in the North Saskatchewan River Valley Ravines. Four of these ravines are Mackinnon Ravine, Mill Creek Ravine, Whitemud Creek Ravine and Groat Ravine. We would like to know how citizens like yourself use these ravines for recreation. Some wildlife exists in these four ravines and it is important for us to know how citizens value this wildlife. You could help to provide better management of these ravines as recreation areas by responding to this questionnaire.

INSTRUCTIONS:

Following is a list of recreation activities that could be done in Mackinnon, Mill Creek, Whitemud Creek and Groat Ravines. For each activity, please check the column that best expresses your feelings about your participation in that activity. Please assume that you have the time and opportunity to engage in each activity. Answer all parts of this question whether you like, dislike or are indifferent to the activity. It is important that you respond to each statement. Following is a list of definitions to refer to as you respond to the statements.

(YOUR REPLIES WILL BE KEPT STRICTLY CONFIDENTIAL)

DEFINITIONS:

Please refer to these definitions as you answer the questions.

(1) SONGBIRDS:

includes songbirds such as sparrows, robins, warblers, waxwings, etc.

(2) OTHER BIRDS:

includes birds of prey such as hawks and owls; upland birds such as pheasants; waterfowl such as ducks and geese; gulls, sandpipers, etc.

(3) MAMMALS:

includes squirrels, chipmunks, bats, mice, etc.

(4) INSECTS:

includes butterflies, bees, etc.

(5) SUMMER:

includes late spring and early autumn

(6) WINTER:

includes late autumn and early spring

(7) RIDE:

includes horseback riding, cycling, boat launching and canoeing

(8) WALK:

includes hiking, strolling, cross-country skiing, snow-shoeing

(9) SPORTS:

includes organized or recreational athletics, downhill skiing, skating, baseball, touch football, tobogganing, etc.

(10) STUDY:

includes keeping written records of observations, counting, identifying, banding, collecting specimens, painting pictures, photographing, tape recording

(11) FISH:

to fish with rod and line for recreation

(12) OBSERVE:

to watch

EXAMPLE

	Dislike very much	Dislike	Indif-ferent	Like	Like very much
WALK in the ravines					
(a) in summer	0	0	0	X	0
(b) in winter	X	0	0	0	0

In this example, the individual
(a) slightly likes doing the activity in summer
(b) dislikes very much the activity in winter

REMEMBER, ANSWER ALL STATEMENTS

BEGIN HERE:

1. PICNIC in the ravines in summer	0	0	0	0	0
2. RIDE in the ravines in summer	0	0	0	0	0
3. RIDE in the ravines in winter	0	0	0	0	0
4. WALK in the ravines in summer	0	0	0	0	0
5. WALK in the ravines in winter	0	0	0	0	0
6. PARTAKE IN SPORTS in the ravines in summer	0	0	0	0	0
7. PARTAKE IN SPORTS in the ravines in winter	0	0	0	0	0
8. FISH in Whitemud Creek in summer	0	0	0	0	0
9. OBSERVE SONGBIRDS in the ravines in summer	0	0	0	0	0
10. OBSERVE SONGBIRDS in the ravines in winter	0	0	0	0	0
11. OBSERVE OTHER BIRDS in the ravines in summer	0	0	0	0	0
12. OBSERVE OTHER BIRDS in the ravines in winter	0	0	0	0	0

	Dislike very much	Dislike	Indif-ferent	Like	Like very much
13. OBSERVE MAMMALS in the ravines in summer	0	0	0	0	0
14. OBSERVE MAMMALS in the ravines in winter	0	0	0	0	0
15. OBSERVE INSECTS in the ravines in summer	0	0	0	0	0
16. STUDY SONGBIRDS in the ravines in summer	0	0	0	0	0
17. STUDY SONGBIRDS in the ravines in winter	0	0	0	0	0
18. STUDY OTHER BIRDS in the ravines in summer	0	0	0	0	0
19. STUDY OTHER BIRDS in the ravines in winter	0	0	0	0	0
20. STUDY MAMMALS in the ravines in summer	0	0	0	0	0
21. STUDY MAMMALS in the ravines in winter	0	0	0	0	0
22. STUDY INSECTS in the ravines in summer	0	0	0	0	0
23. WATCH television programs about wildlife	0	0	0	0	0
24. WATCH movies about wildlife	0	0	0	0	0
25. READ books or magazines about wildlife	0	0	0	0	0
26. STUDY OR OBSERVE wildlife in zoos or game farms	0	0	0	0	0
27. HUNT OR FISH for wildlife	0	0	0	0	0
28. OBSERVE OR STUDY wildlife next to freeways	0	0	0	0	0

	Dislike very much	Dislike	Indif-ferent	Like	Like very much
29. OBSERVE OR STUDY wildlife from an auto	0	0	0	0	0
30. DRIVE an auto for recreation	0	0	0	0	0
31. PARTAKE in recreation next to freeways	0	0	0	0	0

PART II

The following questions will help us to establish who is, and who is not using the ravines for recreation and why. Please answer those parts that pertain to yourself.

A. TO BE ANSWERED BY ALL RESPONDENTS

1. Do you use either Mackinnon, Mill Creek, Whitemud Creek or Groat Ravines for recreation?

yes ____ no ____

If yes, check the one or ones that you use for recreation.

Mackinnon Ravine ____
Mill Creek Ravine ____
Whitemud Creek Ravine ____
Groat Ravine ____

B. DO NOT ANSWER THE THREE FOLLOWING QUESTIONS IF YOU DO NOT USE THE RAVINES FOR RECREATION.

2. Could you please list the activities that you do in the ravines you indicated above.

_____

_____

_____

3. Does the chance that you may encounter wildlife make visits to the ravine or ravines for recreation more enjoyable?

yes ____ no ____

4. How often do you use the ravines for recreation?

In summer

1 or less trips _____
2-5 trips _____
more than 5 trips _____

In winter

1 or less trips _____
2-5 trips _____
more than 5 trips _____

C. ANSWER THE NEXT QUESTION ONLY IF YOU VISIT THE RAVINES SPECIFICALLY TO STUDY OR OBSERVE WILDLIFE ON OCCASION.

5. Why do you visit one or more of these ravines to observe wildlife rather than go elsewhere?

_____

_____

_____

D. ANSWER THE NEXT TWO QUESTIONS ONLY IF YOU DO NOT USE ANY OF THE FOUR RAVINES FOR RECREATION.

6. Why do you not use any of the four ravines for recreation?

_____

_____

_____

7. Why do you not use any of the four ravines for observing or studying wildlife?

_____

_____

_____

PART III

Your answers to the following questions will help us to determine who is and who is not using the ravines for recreation. Your answers will be, of course, held in the strictest of confidence.

1. What sex are you: Male ____ Female ____

2. What year were you born in? _____

3. What is your present occupation? _____

4. What level of schooling have you received? (Check one)

public school	____	high school	____
university	____	technical school	____

5. What type of home do you live in? (Check one)

high rise apartment	_____
walk up apartment	_____
duplex	_____
single detached house	_____

6. How long have you lived in Edmonton? (Check one)

2 years or less	_____
2 - 5 years	_____
5 - 10 years	_____
more than 10 years	_____

7. In what range approximately does your annual income fall? (Check one)

NOTE: If you reside with parents, indicate the family annual income.

less than $2,000	_____
$ 2,001 - $ 6,999	_____
$ 7,000 - $ 9,999	_____
$10,000 - $14,999	_____
$15,000 or more	_____

8. Approximately how many weeks of vacation do you have each year? (Check one)

2 weeks or less	_____
3 - 4 weeks	_____
4 - 8 weeks	_____
more than 8 weeks	_____

9. How many days do you work in a week? Circle the one which pertains to you. For students, indicate the number of days in a week you attend school.

1 2 3 4 5 6 7

10. Do you or your immediate family own a vacation home that you visit?

yes _____ no _____

11. Do you hunt or fish?

yes _____ no _____

PART IV

Do you have any comments?

_____

_____

_____

_____

_____

Your cooperation in answering and returning this questionnaire is greatly appreciated.

APPENDIX C

VEGETATION ANALYSES OF SAMPLE PLOTS

TABLE 46

GROAT ROAD GRASSLAND PLOT

Exposure: south-facing

Slope: approximately 39°

Species	Per Cent Distribution (ocularly estimated)
brome spp.	
white sweet clover	
northern bedstraw	
goatsbeard	89
wild vetch	
wild lupine	
thistle spp.	
rose spp.	3
saskatoon berry	3
silver berry	3
white pruce	2
Total	100

TABLE 47

WHITEMUD CREEK RAVINE GRASSLAND PLOT

Exposure: east-facing

Slope: approximately 44°

Species	Per Cent Distribution (ocularly estimated)
brome spp. vetch spp. annual hawksbeard northern bedstraw	80
silver erry	10
rose spp.	5
balsam poplar	2
trembling aspen	1
white spruce	1
Total	100

TABLE 48

WHITEMUD CREEK RAVINE SHRUBLAND PLOT
PER CENT COVERAGE BY PLANT SPECIES PRESENT

Exposure: south-west-facing

Slope: approximately 47°

Species	Per Cent Distribution of Cover
snowberry	57
saskatoon berry	28
silver berry	15
Total	100
Amount covered by shrubs	45.5

TABLE 49

MACKINNON RAVINE SHRUBLAND PLOT
PER CENT COVERAGE OF PLANT SPECIES PRESENT

Exposure: south-facing

Slope: approximately 52°

Species	Per Cent Distribution of Cover
saskatoon berry	48
choke-cherry	31
round-leafed hawthorne	16
rose spp.	4
snowberry	1.0
Total	100
Amount covered by shrubs	56.5

TABLE 50

WHITEMUD CREEK RAVINE WHITE SPRUCE-POPLAR PLOT
PER CENT COVERAGE OF PLANT SPECIES PRESENT

Exposure: north-east-facing

Slope: approximately 30°

Species	Per Cent Distribution of Cover
Overstory:	
white spruce	55
balsam poplar	17
Total	72
Amount of overstory cover	72
Understory:	
beaked hazelnut	36.7
red osier	22.0
raspberry	16.0
rose spp.	7.4
Canadian buffalo berry	5.9
currant spp.	5.9
mountain ash	2.9
trembling aspen	1.5
highbush cranberry	1.5
Total	100
Amount of understory cover	63

TABLE 51

GROAT RAVINE WHITE SPRUCE-POPLAR PLOT
PER CENT COVERAGE OF PLANT SPECIES PRESENT

Exposure: east-facing

Slope: approximately 35°

Species	Per Cent Distribution of Cover
Overstory:	
balsam poplar	58
white spruce	42
Total	100
Amount of overstory cover	60
Understory:	
beaked hazelnut	44
red osier	20
cranberry spp.	12
rose spp.	10
balsam poplar	8
trembling aspen	6
Total	100
Amount of understory cover	58

TABLE 52

MILL CREEK RAVINE WHITE SPRUCE-WHITE BIRCH PLOT
PER CENT COVERAGE BY PLANT SPECIES PRESENT

Exposure: west-facing

Slope: approximately 29°

Species	Per Cent Distribution of Cover
Overstory:	
white birch	71
white spruce	29
Total	100
Amount of overstory cover	66
Understory:	
saskatoon berry	17.9
red osier	15.8
silver berry	15.8
beaked hazelnut	11.6
pin cherry	10.5
white birch	8.4
Canadian buffalo berry	7.4
rose spp.	6.3
willow spp.	4.2
trembling aspen	2.1
Total	100
Amount of understory cover	53.5

TABLE 53

WHITEMUD CREEK RAVINE WHITE SPRUCE-WHITE BIRCH PLOT
PER CENT COVERAGE BY PLANT SPECIES PRESENT

Exposure: west-facing

Slope: approximately 10°

Species	Per Cent Distribution of Cover
Overstory:	
white birch	64
white spruce	36
Total	100
Amount of overstory cover	78.5
Understory:	
willow spp.	40
red osier	12
pin cherry	11
rose spp.	10
balsam poplar	9
white birch	5
white spruce	4
trembling aspen	4
alder	4
Canadian buffalo berry	1
Total	100
Amount of understory cover	66.5

TABLE 54

WHITEMUD CREEK RAVINE WHITE BIRCH-POPLAR PLOT
PER CENT COVERAGE BY PLANT SPECIES PRESENT

Exposure: neutral

Slope: approximately 3°

Species	Per Cent Distribution of Cover
Overstory:	
balsam poplar	69
white birch	31
Total	100
Amount of overstory cover	71
Understory:	
alder	37
rose spp.	28
pin cherry	22
red osier	8
snowberry	4
raspberry	1
Total	100
Amount of understory cover	70

TABLE 55

MACKINNON RAVINE WHITE BIRCH-POPLAR PLOT
PER CENT COVERAGE BY PLANT SPECIES PRESENT

Exposure: south-west-facing

Slope: approximately 30°

Species	Per Cent Distribution of Cover
Overstory:	
white birch	29
trembling aspen	71
Total	100
Amount of overstory cover	62
Understory:	
beaked hazelnut	41
red osier	22
balsam poplar	10
willow spp.	10
white birch	7
saskatoon berry	6
rose spp.	3
pin cherry	1
Total	100
Amount of understory cover	78.5

TABLE 56

GROAT RAVINE POPLAR PLOT
PER CENT COVERAGE BY PLANT SPECIES PRESENT

Exposure: north-east-facing

Slope: approximately 8°

Species	Per Cent Distribution of Cover
Overstory:	
trembling aspen	68
balsam poplar	32
Total	100
Amount of overstory cover	78
Understory:	
saskatoon berry	42
beaked hazelnut	30
red osier	8
pin cherry	6
rose spp.	4
Canadian buffalo berry	4
white birch	2
trembling aspen	2
balsam poplar	2
Total	100
Amount of understory cover	65.5

TABLE 57

MACKINNON RAVINE POPLAR PLOT
PER CENT COVERAGE BY PLANT SPECIES PRESENT

Exposure: neutral

Slope: approximately 3°

Species	Per Cent Distribution of Cover
Overstory:	
balsam poplar	68
trembling aspen	32
Total	100
Amount of overstory cover	62
Understory:	
cherry spp.	50
red osier	18
beaked hazelnut	12
saskatoon berry	9
balsam poplar	5
rose spp.	4
willow spp.	2
Total	100
Amount of understory cover	95

TABLE 58

MACKINNON RAVINE WHITE SPRUCE PLOT
PER CENT COVERAGE BY PLANT SPECIES PRESENT

Exposure: north-east-facing

Slope: approximately 50°

Species	Per Cent Distribution of Cover
Overstory:	
white spruce	100
Total	100
Amount of overstory cover	50
Understory:	
mountain ash	66.7
Canadian buffalo berry	20.8
white birch	12.5
Total	100
Amount of understory cover	11

TABLE 59

MILL CREEK RAVINE WHITE SPRUCE PLOT
PER CENT COVERAGE BY PLANT SPECIES PRESENT

Exposure: west-facing

Slope: approximately 4°

Species	Per Cent Distribution of Cover
Overstory:	
white spruce	100
Total	100
Amount of overstory cover	66
Understory:	
red osier	41.6
choke-cherry	16.7
rose spp.	16.7
beaked hazelnut	25.0
Total	100
Amount of understory cover	15

APPENDIX D

LIST OF COMMON AND SCIENTIFIC NAMES OF BIRDS

western grebe	*Aechmophorus occidentalis*
tufted duck	*Aythya fuligula*
mallard	*Anas platyrhychos*
red-tailed hawk	*Buteo jamaicensis*
merlin	*Falco columbarius*
american kestrel	*Falco sparverius*
ruffed grouse	*Bonasa umbellus*
ring-necked pheasant	*Phasianus colchicus*
gray partridge	*Perdix perdix*
spotted sandpiper	*Actitus macularia*
california gull	*Larus californicus*
ring-billed gull	*Larus delawarensis*
franklin's gull	*Larus pipixcan*
rock dove	*Columba livia*
woodpigeon	*Columba palumbus*
great horned owl	*Bubo virginianus*
snowy owl	*Nyctea scandiaca*
hawk owl	*Surnia ulula*
ruby-throated hummingbird	*Archilochus colubris*
common flicker	*Colaptes avratus*
pileated woodpecker	*Dryocopus pileatus*
yellow-bellied sapsucker	*Sphyrapicus varius*
hairy woodpecker	*Dendrocopus villosus*
downy woodpecker	*Dendrocopus pubescens*
black-backed three-toed woodpecker	*Picoides articus*
northern three-toed woodpecker	*Picoides fridactylus*
eastern kingbird	*Tyrannus tyrannus*
say's phoebe	*Sayornis saya*
least flycatcher	*Empidonax minimus*
olive-sided flycatcher	*Nuttalornis borealis*
tree swallow	*Iridoprocne bicolor*
purple martin	*Progne subis*
blue jay	*Cyanocitta cristata*
jay	*Garulus glandaris*
black-billed magpie	*Pica pica*
common crow	*Corvus Brachyrhynchos*
black-capped chickadee	*Parus atricapillus*
boreal chickadee	*Parus hudsonicus*
white-breasted nuthatch	*Sitta carolinensis*
red-breasted nuthatch	*Sitta canadensis*
house wren	*Troglodytes aedon*
gray catbird	*Dumetella carolinensis*
brown thrasher	*Toxostoma rufum*
american robin	*Turdus migratorius*
veery	*Hylocichla fuscescens*

ruby-crowned kinglet	*Regulus calendula*
bohemian waxwing	*Bombycilla garrula*
cedar waxwing	*Bombycilla cedrorum*
red-backed shrike	*Lanius collurio*
starling	*Sturnus vulgaris*
red-eyed vireo	*Vireo olivaceus*
warbling vireo	*Vireo gilvus*
tennessee warbler	*Vermivora peregrina*
yellow warbler	*Dendroica petechia*
house sparrow	*Passer domesticus*
western meadowlark	*Sturnella neglecta*
red-winged blackbird	*Agelaius phoeniceus*
northern oriole	*Icterus galbula*
rusty blackbird	*Euphagus carolinus*
common crackle	*Quiscalus quiscula*
brown-headed blackbird	*Molothrus ater*
western tanager	*Piranga ludoviciana*
evening grosbeak	*Hesperiphona vespertina*
pine grosbeak	*Pinocola enucleator*
hoary redpoll	*Acanthis hornemanni*
common redpoll	*Acanthis flammea*
pine siskin	*Spinus pinus*
american goldfinch	*Spinus tristis*
red crossbill	*Loxia curvirostra*
white-winged crossbill	*Loxia leucoptera*
savannah sparrow	*Passerculus sandwichensis*
dark-eyed junco	*Junco hyemalis*
tree sparrow	*Spizella arborea*
chipping sparrow	*Spizella passerina*
clay-coloured sparrow	*Spizella pallida*
white-crowned sparrow	*Zonotricia leucophrys*
white-throated sparrow	*Zonotricia albicollis*
song sparrow	*Melospiza melodia*

APPENDIX E

LIST OF COMMON AND SCIENTIFIC NAMES OF PLANTS

white spruce	*Picea glauca*
brome grass	*Bromus* spp.
wheat grass	*Agropyron* spp.
balsam poplar	*Populus balsamifera*
trembling aspen	*Populus tremuloides*
willow	*Salix* spp.
alder	*Alnus* spp.
white birch	*Betula papyrifera*
beaked hazelnut	*Corylus* spp.
wild currant	*Ribes hudsonianum*
goatsbeard	*Tradopogon dubius*
western mountain ash	*Sorbus scopulina*
saskatoon berry	*Amelanchier alnifolia*
round-leafed hawthorne	*Crataegus chrysocarpa*
pin cherry	*Prunus pennsylvanica*
choke-cherry	*Prunus virginiana*
wild red raspberry	*Rubus strigosus*
rose	*Rosa* spp.
wild lupine	*Lupinus argentus*
common red clover	*Trifolium pratense*
white sweet clover	*Meliotus alba*
white clover	*Trifolium repens*
wild vetch	*Vicia americana*
purple wild pea vine	*Lathyrus venosus*
silver berry	*Elaeaganus commutata*
canadian buffalo berry	*Shepherdia canadensis*
red osier dogwood	*Cornus stolonifera*
northern bedstraw	*Galium boreale*
snow berry	*Symphoricarpos albus*
buckbrush	*Symphoricarpos occidentalis*
low bush cranberry	*Viburnum edule*
high bush cranberry	*Viburnum trilobum*
aster	*Aster* spp.
thistle	*Cirsium* spp.
annual hawksbeard	*Crepis tectorum*

APPENDIX F

LIST OF COMMON AND SCIENTIFIC NAMES OF MAMMALS

little brown bat	*Myotis lucifugus*
least weasel	*Mustela rixosa*
mink	*Mustela vison*
striped skunk	*Mephitis mephitis*
coyote	*Canis latrans*
Canada lynx	*Lynx canadensis*
woodchuck	*Marmota monax*
richardson ground squirrel	*Cittelus richardsonii*
least chipmunk	*Eutamias minimus*
red squirrel	*Tamiasciurus hudsonicus*
beaver	*Castor canadensis*
muskrat	*Ondatra zibethica*
porcupine	*Erthizon dorsatum*
whitetail jackrabbit	*Lepus townsendi*
snowshoe hare	*Lepus americanus*
eastern cottontail	*Sylvilagus floridanus*
white-tailed deer	*Odocoileus virginianus*
moose	*Alces alces*